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JUNE, 1930

SCHOOL SCIENCE AND MATHEMATICS

FOUNDED BY C. E. LINEBARGER

A Journal for all SCIENCE AND MATHEMATICS TEACHERS

CONTENTS:

A Nature Trail
Learning About Food
Junior High School Science
Mathematics Recreational Program
A Three-Year Course In General Science

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SCHOOL SCIENCE AND MATHEMATICS

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SCIENCE IN THE ELEMENTARY SCHOOL.

By HARRY A. CARPENTER.

Specialist in Science, Rochester, N. Y.

What has brought about the rather insistent demand of many elementary school principals, and of superintendents for science adapted for the elementary school child? Certainly the demand is here and it constitutes a challenge to science teachers to provide adequate science opportunities for these children.

Nature study as such has apparently failed to meet the needs and it behooves the science teacher and supervisor to look for reasons for its failure and so avoid, if possible, making the same mistakes in developing a course in science.

There are two fundamental causes to which the failure of nature study may be ascribed, namely, lack of any progressive plan by which the work of one grade was articulated with another, and the lack of adequately trained and interested teachers.

A third reason to be considered has been the lack of a comprehensive plan for a twelve year course in science. No one can successfully organize science for the elementary grades without due consideration for the science of the junior high school and the senior high school. In fact the traditional organization of science into compartmental units essentially unrelated to each other is doubtless a fundamental cause for the more or less unconcern of administrators with respect to an adequate time allotment for science in the senior high school. This lack of organization in the upper levels has served to retard a satisfactory organization for the lower levels.

The lack of organization in the senior high school has

been due in the opinion of the writer not only to traditional and sacred boundary lines of the special sciences and the conservative demands of the colleges for a kind of preparation which enables the student to learn and repeat the written dogmas of science textbooks and the spoken dogmas of the instructor, but most of all because the outcomes (perhaps one should say the incomes to the pupil) have been determined mostly by memory tests and so the organization has been one of facts and principles to be memorized rather than a development of attitudes of understanding and appreciation.

Things and their relationships are only the tools of understanding, of thinking, and of appreciation. If one teaches only the facts about science and fails to provide a plan by use of which the pupil is made to think, to understand, and to appreciate, then the real outcomes of science training are defeated.

What is the use of the findings and reports of committees of the Department of Superintendence and published in their Yearbooks suggesting more worthwhile objectives of teaching if the standardizing agencies of education will not change and so limit the classroom teacher to the teaching of facts when he should be expending his energy for the training of the child?

That there is great need for sensible science teaching from the kindergarten to the twelfth year of the senior high school no one will deny. A sensible science program will be based primarily upon the development of attitudes of understanding and appreciation through the vehicle of the facts of science and not for the sake of the facts.

Many splendid experiments in the working out of such a science course for the elementary school are being carried on here and there throughout the country. Experiences gained from every one of these should be made available to others in need of help through publication in educational journals.

The writer would be one of the last to suggest that science teaching is a failure—on the contrary it is one of the bright spots in the school curriculum today and promises large for tomorrow. It is only that the writer is impatient with the slowness with which tradition, which amounts almost to a superstition, makes way for progress.

THE SCIENCE SITUATION.

By Ira C. Davis,

University High School, Madison, Wis.

If you were asked to organize a twelve year program in science for the elementary and secondary schools, how would you begin? Would you begin at the top, as we did a few years ago, by selecting a few topics from physics, chemistry, botany, zoology and physiography, throw them together, and call them courses in general science and biology? It didn't work very well. The trouble is, we forgot the pupil. Recent textbooks have proceeded with the opposite viewpoint. They have organized the subject matter around the present activities and interests of the pupils. Our Junior High School science is still dominated by what the Senior High School demands.

Many of the larger cities are finding it necessary to teach science in the elementary schools. They have organized courses from the first to the sixth grades inclusive. Should they organize the subject matter by selecting topics or units from Junior and Senior High School science or should they forget that such courses existed, and begin at the bottom?

Science instruction in the Junior High Schools lags behind English, mathematics and social studies. It does not receive as much emphasis and less time is given to it. The teaching of nature study or elementary science cannot be compared with language, mathematics, history and geography in the elementary school. Should science be placed on an equal basis with them? Is it receiving the emphasis it deserves?

The following statistics emphasize the need of science instruction in the lower grades. Of one hundred pupils entering the first grade, only eighty-three begin the sixth grade; seventeen leave school while they are in the fifth grade. Twelve more leave school in the sixth grade, eight more in the seventh grade and only thirty-four of the original one hundred begin the ninth grade. Eight more leave school during the ninth grade. What science instruction are we offering the seventy-four per cent that leave school before they reach the tenth grade? They will never have an opportunity to study biology, chemistry, or physics. Most of these boys will go into industry or will do manual

labor. The girls will go into industry or do household work. They need science to help them solve their difficulties in earning a living and adjusting themselves to changes. Does anyone need science more than they do?

Many investigations and studies need to be conducted to find the subject matter most suitable for each grade. The best methods of teaching at the different levels need to be determined. Many teachers claim that science is not adapted for instruction in the lower grades. Studies show that boys and girls are intensely interested in animals and plants. Boys seven to twelve years of age operate electric trains, perform experiments with chemistry sets, take motors apart, put them together, and make them run. They are doing the things we say they cannot do. They are learning their science outside of the classroom. An eight year old boy, normal in every respect, lost interest in running his electric train on a circular track. He wondered if it would run on a straight track. He tried it, and to his amazement it ran from one side of the room to the other. He soon lost interest in running the train from one end to the other because he found it necessary to push it back, or turn it around and let the motor drive it back. He soon conceived the idea that if the track was made to slope upward, the engine would coast back. He tried it and it worked. The current was turned off when the engine approached the top. It coasted back, and as the engine neared the end of the track, the current was turned on and the motor was used as a brake. Then he was anxious to know how steep a grade the motor would climb. The slope of the track was increased until the motor failed to develop enough power to drive the engine upwards. He had also discovered that as the slope was increased, the engine coasted back more rapidly. It became more difficult to control the motor. If the current was turned on suddenly the wheels would slip and the engine would slide down the tracks. This boy completed these experiments in one afternoon without any assistance or suggestions from any one. How far removed was this boy from an understanding of power, mechanical advantage, efficiency, acceleration, coefficient of friction and the inclined plane, to say nothing of the electric motor, circuits, and the transformer? Many teachers hesitate to teach these principles to a class in phys-

ics because they are too difficult. This boy designed his own experiments to play with all of them in one afternoon.

It would be foolish to draw conclusions from this case alone. But it does illustrate the type of situations or problems that should be presented to pupils at different levels to discover what they are capable of doing. Many of the problems presented will be unsatisfactory. It is better to discover experimentally that they are unsatisfactory than it is to assume they are. Enough problems could be selected in this way for each grade in the elementary school. Then problems could be determined for the Junior High School as a development from the Elementary School. The special sciences will be taught in the Senior High School. Many changes and adjustments will be necessary in the special sciences, depending upon the developments that occur in the Elementary and Junior High Schools.

This issue of SCHOOL SCIENCE AND MATHEMATICS includes reports of studies and investigations that are being conducted in Los Angeles, Denver, and Springfield, Mo. It is hoped that these reports will stimulate other cities to let teachers know what they are doing.

SHOULD ELEMENTARY SCIENCE BE A REQUIRED PRE-REQUISITE FOR THE STUDY OF BIOLOGY?

By MAY A. BENNETT, *Macomb, Ill.*

My reply is "Yes." My answer is based upon the experience which I have each year in supervision of the teaching of tenth grade Biology in our high school department. Those pupils coming from our elementary practice school have all had such a course. Very few of those admitted from the surrounding territory have had. I attempt to divide my groups on basis of this previous course. Those who have had elementary science have a broader view of the scope of science, they recognize to some degree the relation of Biology to other sciences and can more easily be shown its contribution to science in general. Moreover, these people have an interest from the very beginning which is not true of those from the other group. Hence time and effort is conserved in the introduction of the course. In the third place, a certain mass of subject matter and some understanding of scientific principles, either introductory to or an integral part of Biology, have been acquired, thus making possible a much fuller development of this science than would otherwise be possible.

Because of the better scientific orientation, of a pupil who has had elementary science because of the time and effort conserved by the fact that interest in Biology on the part of such pupils requires less stimulation, and because of the opportunity for a fuller and more complete development of this course due to a previous acquisition of basic and contributory facts and principles therefore, I believe in a pre-requisite of elementary science for Biology.

THE DEVELOPMENT OF SCIENCE IN THE JUNIOR HIGH SCHOOLS OF DENVER.

By HAZEL B. WATKINS

Chairman, Junior Science Committee,
Denver Public Schools.

FIRST COURSE IN JUNIOR SCIENCE.

A committee of junior high school science teachers is endeavoring to have ready by the beginning of school in September, 1930, a tentative, mimeographed revision of the course in general science for the seventh and eighth grades, and earth science for the ninth grade. This article is a brief survey of the continuous program of revision which has been carried on during the past eight years.

The junior high school course of study in science was first revised and printed in 1924. This revision was the result of two years' work by a committee of teachers. Previous to this time, science was required of all ninth grade students for five periods a week through both semesters. The revised course required general science in the seventh and eighth grades and offered an elective course in biology for the ninth grade. The time allotment was three periods a week in 7B, two in 7A, three in 8B, two in 8A, and five in each of 9B and 9A.

The subject matter of the course was organized around the following themes:

Seventh grade—each topic planned to cover six weeks: The Sun's Gift of Heat, The Air We Breathe, The Waters of the Earth, Weather and Climate, How Fuels Serve Man, Science in the Household.

Eighth grade—each topic planned to cover four weeks: The Science of Familiar Things, The Work of the World, How We See, The Heavenly Bodies, Time and Seasons, The Crust of the Earth, Life Upon the Earth.

Ninth grade—each topic planned to cover seven weeks: Life in a Vacant Lot, Life in Our City Parks, Life in and about a Lake or Pond, Life on the Plains and in the Mountains, Man in His Environment.

The order of topics was determined by the season in both eighth and ninth grades so as to have more material available for laboratory study.

REVISION OF THE 1924 COURSE.

The 1924 course of study was in use for two years. During this time rapid advancement in the field of general science had made available new teaching materials. Experience with the course had indicated certain desirable lines

of revision. This second revision in tentative form was mimeographed to be used in 1926 as a basis for further critical study. The science work in the eighth grade was reorganized to suit a five period per week program for the 8A and none for the 8B. This change involved also certain readjustments in the subject matter as follows:

7B—three periods per week: The Air We Breathe—six weeks; The Waters of the Earth—eight weeks; Weather and Climate—four weeks.

7A—two periods per week: The Heavenly Bodies—eight weeks; The Crust of the Earth—four weeks; Science in the Household—six weeks.

8A—five periods per week: Work of the World—eight weeks; Life upon the Earth—six weeks; Body and Health—four weeks.

Biology in the ninth grade was replaced by earth science, an introductory course in geology. The time allotment was changed. The course was organized around the following themes:

9B—three periods per week: The Planet Earth and Human Life—four weeks; Climate and Human Life—ten weeks; Earth's Surface and Human Life—four weeks.

9A—three periods per week: The Soil and Human Life—eight weeks; Minerals and Human Life—four weeks; Plants and Animals and Human Life—six weeks.

Need for a more flexible course had been felt, so the subject matter in the seventh and eighth grades was organized to indicate minimum essentials, supplemented by material for elaboration which was suggestive to teachers in selecting and adapting the course to the needs and capacities of various pupils. Page references in seven supplementary science text books and the adopted text were listed at the end of each section of the course, also a supplementary page reference list selected from books in the school libraries, and helpful magazine articles, bulletins, illustrative materials such as slides and films, exhibits (exclusive of advertising matter) and a list of activities suitable for pupils to do for themselves. The mimeographed form also contained a bibliography for teachers, a list of general references such as encyclopedias, and a list of other science text books available in the school libraries. The introduction gave a defense of science, an explanation of the organization of the course, a statement of general and specific aims, the basis upon which the course was organized, suggestions as to methods of class-

room instruction and group activities outside the classroom, a list of aids in teaching and learning, and samples of different types of tests.

Organization for Critical Study.

When school opened in September, 1926, all science teachers were called together to make plans for an intensive study of the course then in use. The suggestion that each be given an opportunity to participate was received with enthusiastic approval. Each teacher chose the section of the outline in which she was most interested. A committee was organized for each half grade. The chairmen of these "subcommittees" were members of a so-called "central committee" composed, as in previous years, of one science teacher for each junior high school. The subcommittees worked industriously, holding their meetings after school. The chairmen reported their progress and recommendations to the central committee. Some of the changes they suggested were put into typed form and sent to other committee members for use in their classrooms. The results have proved to be quite helpful in the present process of revision.

The next year the appraisal of the course was continued in order to evaluate further the content and method as a basis for the present revision, supplementing the criticisms made by the committee the year before. All science teachers were invited to participate in the work of appraisal and urged to report their convictions frankly either by filling out a form sheet or by writing informally. About seventy percent of the junior science teachers responded. In addition to the work of the junior science teachers, one appraisal was made by an elementary science teacher and one by a senior high school science teacher.

The summary of the appraisals indicated that some very definite changes were needed. Some are listed:

1. The science courses are overcrowded.
2. There is too great emphasis upon factual material, and not enough upon child interests and experiences.
3. There should be more careful adjustment both as to individual differences and different group levels.
4. Standards of attainment need to be set up.
5. The outline form should be modified.
6. Methods for remedial work and for guidance of inexperienced teachers need elaboration.
7. The mechanical organization should be revised.

Specialists in the field of science and education have been brought to Denver from time to time to give advice on our problem. Some of them are as follows: Dr. T. H. Briggs and Dr. T. D. Wood of Teachers College, Columbia University; Dr. J. O. Frank, Oshkosh Normal School, Oshkosh, Wisconsin; Dr. Otis Caldwell, director and Dr. H. O. Rugg of Lincoln School, Teachers College, Columbia University; and Dr. Edith M. Selberg, Colorado Teachers College, Greeley.

THE PRESENT PROGRAM.

This year the assistance of Dr. S. R. Powers, Professor of Natural Sciences, Teachers College, Columbia University was secured. He brought some very helpful points of view. According to his advice, the course is being organized around big ideas, or major goals of learning. These big ideas are "definable in terms of the learner, and suggestive of tangible or definite outcomes." They are being tested for bigness "by the study of the extent to which they have within them the potentialities for influencing the physical and mental adjustments of human beings."

The big ideas were chosen from the whole field of science. An effort has been made to give a definite sequence in the order of objectives, and to make for unity rather than the hodge-podge organization of which the early courses in general science were guilty. The big ideas are tentatively as follows:

1. The earth is but one of many astronomical bodies. Its movements follow laws that are common to other planets.
2. The earth was formed by natural forces acting upon matter already in existence. These forces have been acting over a long period of time and continue to act.
3. Air and water are dominant factors in the physical environment.
4. Energy may be manifested in many forms which can be put to practical purposes. It can neither be created nor destroyed but may be transformed.
5. Plants and animals are fitted for the living conditions in which they are found.
6. Health and physical vigor are characterized by the proper functioning of the organs of the body.

Before proceeding with the development of the big ideas, Dr. Powers advised that writings of specialists in the outstanding fields of science be consulted with particular attention to what they have written for the general reader, that is, for the reader who knows little science. For this

purpose the science committee was divided into groups, and each group concentrated on the development of one major goal or big idea. Each big idea had to be analyzed into specific objectives which would make clear to the teacher the choice of subject matter and activities needed for its accomplishment. The specific objectives in turn had to be further analyzed into contributory meanings in order to provide a more detailed treatment showing the development of the objective. Each objective and each contributory meaning is being stated in a complete declarative sentence in order to convey more clearly the desired outcomes and in order to keep before the teacher the relationship between the contributory meaning and the big idea. No subject matter will be included which does not have a direct bearing on the objective. In the last analysis, the study of science is for its functional value. A body of facts is valueless unless so organized as to build up an understanding of a scientific principle.

The following principles were proposed by Dr. Powers as general criteria for evaluating the statement of big ideas, specific objectives and contributory meanings:

1. A statement of aims or objectives which is functional for teachers and curriculum workers should be sufficiently specific to suggest the nature of the subject matter which is appropriate for its accomplishment.
2. It should suggest values which are recognizable, after accomplishment, in their effects on the behavior of the learner.
3. It should suggest accomplishment which has social value.
4. It should suggest subject matter and values which challenge the interests of children of the grade level for which it is set for attainment.

To illustrate the organization of subject matter used, the following extract is given. It must be understood that the course is in the process of making and subject to change.

Big Idea: Energy may be manifested in many forms which can be put to practical purposes. It can neither be created nor destroyed, but may be transformed.

Specific Objective: The sun is the source of energy for mechanical and vital processes. Solar energy is being continually transformed by natural processes.

Contributory Meanings:

1. Energy from the sun causes the water cycle.
2. Solar energy causes evaporation.
3. Loss of energy by cooling causes condensation.
4. The force of gravity causes water to flow.
5. Water power is derived from flowing water.
6. Water wheels transform the energy of falling water into useful form.
7. Energy from the sun makes the wind blow.

8. Winds result from unequal atmospheric pressure due to unequal heating.
9. Wind mills transform the energy of winds to useful purposes.
10. Energy of the wind may be destructive.
11. Energy from the sun causes growth.
12. Wood, coal, petroleum and natural gas carry stored up solar energy which is released as heat energy by the chemical change known as burning.
13. Food contains stored up solar energy which is released by chemical changes in the body.
14. Energy from the sun causes certain chemical changes.
15. Fading of colored materials results from exposure to the sun.
16. The chemical changes on a photographic plate are due to energy of the sun's rays.
17. Freckles and tan are due to chemical reactions brought about by the sun's rays.
18. Chemical changes in green plants are made possible by the energy of the sun.

The other specific objectives of the outline on energy are: Machines are devices for transforming energy. Magnetism and electricity are forms of energy.

This outline is to be used by the teacher as a guide in planning the daily work. The big idea is the major goal for learning and each specific objective or contributory meaning helps to show the steps in building up this understanding. In directing learning experiences, the teacher must present real challenges which stimulate study and thinking. Such challenges will usually involve problem situations. This course of study makes no attempt to state challenging problems, but leaves the responsibility for their formulation and presentation to the teacher.

To make the course more adaptable to different ability levels, there will be supplementary objectives for the higher groups, extra reports, and suggested extra readings. The course will leave plenty of opportunity for teacher initiative both in adapting the course to suit the students and in choosing learning experiences suitable for certain objectives.

In addition to the treatment of objectives the course will contain an introduction to explain the general plan of organization and the meanings of terms used. There will also be bibliographies for teachers and for pupils, suggested activities, and standards of attainment. To make the course of study more helpful to the inexperienced teacher, some attention will be given to methods.

All lists of the aims of general science include the development of scientific attitudes and training in the use of

scientific methods. Dr. Powers proposes to accomplish these two aims as follows: "It must be clear that one cannot teach a scientific attitude unless the attitude has been objectified by a clear definition. May we say that a scientific attitude is developed from appreciation of the fact that man's conception of truth changes? If this definition is acceptable it would seem that the most effective way to develop this attitude is to take the learner through a variety of learning experiences which illustrate how man's conception of truth respecting some particular thing (the age of the earth, for example) has changed. There is need for research which will reveal clearer definitions of the scientific attitudes and for research which will reveal the teaching situations by means of which the learner may come to a functional understanding of them. The same point of view is applicable to discussion of scientific methods. There is need for definition of the elements of the scientific methods which are functional for individuals who are not employed as special workers in one of the fields of science. There is need for caution that the enthusiast for science must not claim too much. It is unlikely that the detailed methods of scientific research will be of any consequence in the daily affairs of the man on the street. There is need for research which will result in a definition of the methods of scientific study which may be generally functional. Then, there is need for research which will reveal the learning situations through which the learner may come to mastery of them. It is suggested that the learner may arrive at an understanding of the scientific methods through study of situations in which particular methods have been applied, and that he will come to a mastery of them if learning situations are set in which he is required (or permitted) to use elements of the methods, the definitions of which are clearly understood."[1]

The staff of the Colorado Museum of Natural History is cooperating with the Denver Public Schools in making out a program for the correlation of their exhibits with the course of study. Lesson sheets to serve as guides for field trips in connection with the class work will be worked out and some form of follow-up test may be used. This is in the experimental stage at present but shows great possibilities.

CONCLUSION.

During the eight years since the first teacher committee began revision of the junior high school course in science, the science program has been constantly in process of revision. The course is still in a very tentative form and what has been indicated here as a possible solution for the immediate needs of junior science is subject to further change. Plans are being considered for the development of a twelve year science program to be organized by the combined efforts of the elementary, junior, and senior high school science teachers. The course of study now being prepared will be used during the two or three years which will be required for the preparation of the proposed twelve year program.

[1]From Powers, S. R., Research in Science Teaching. Teachers College Record, 30:334—342, Number 4, January, 1929.

DEPARTMENT OF SCIENCE INSTRUCTION, N. E. A., COLUMBUS, OHIO.

President, E. Laurence Palmer, Director of Nature Education, Cornell University, Ithaca, N. Y.

Secretary, Ralph K. Watkins, Associate Professor of Education, University of Missouri, Columbia, Mo.

FIRST SESSION

Tuesday, July 1, 2:00 p. m., Heatons Music Store

The Place of Science Instruction in General Elementary School Program, by O. G. Brim, Professor of Elementary Education, Ohio State University.

Motion Pictures as a Vehicle of Instruction in Elementary Schools, by Dr. Thomas Finegan, Eastman Teaching Films, Rochester, New York.

SECOND SESSION

Wednesday, July 2, 2:00 p. m., Heatons Music Store

Vital Values of Science Instruction to be found in Text Books, by Dr. Benjamin C. Gruenberg, 18 East 48th St., New York City.

The Essentials of Planning a Science Program for Secondary Schools, by Earl R. Glenn, Professor of Physics, New Jersey State Teachers College, Upper Montclair, N. J.

The Essential Values of Science Tests in High School, by Thomas L. Bayne, Assistant Professor of Rural Education, Cornell University, Ithaca, N. Y.

Essential Elements Involved in the Training of High School Teachers, by Dr. Charles Pieper, New York University, New York City.

Vital Values Being Developed Through Recent Research in Science Instruction Concerned with Methods of Teaching, by Ralph K. Watkins, Associate Professor of Education, University of Missouri, Columbia, Mo.

THE MATHEMATICS LIBRARY AND RECREATIONAL PROGRAMS.

By S. Helen Taylor,
University High School, Urbana, Ill.

In the University High School it is our good fortune to have an unusually well chosen group of books for each department and also to have the cooperation of a well trained librarian who is always ready to assist us. Through a number of years' work there, we have grown into the feeling that the library is no small factor in developing a general school interest in mathematics and in maintaining certain high standards in the more routine work of the class room.

By their confessed lack of familiarity with the literature, two groups have impressed us with a need for frequently presenting this matter of reference books in mathematics and their uses. The first group, our seniors in educational practice, as they come to us each semester have had almost no previous contact with fallacies, puzzles, games, report topics, biographical and historical material, bulletin board notes, or plays. The second group includes many teachers of experience who have occasion to visit us or to be in contact with our staff. We have frequent requests from them for book lists, names of plays, or any help we may give along the line of recreational material.

There have been many articles on "Mathematics Club Programs" in both School Science and Mathematics and in the "Mathematics Teacher." Many of the best of these articles and bibliographies were in issues of the period 1915 to 1925. Few high schools have made these numbers permanently available so it is frequently of no value to refer teachers to such articles.

There is no Mathematics Club in University High. However, each department of the school is responsible for one of the weekly assembly programs. The mathematics assemblies have always been especially popular. In addition to these programs, usually the day before a vacation is used for programs in some of the class hours with a student committee in charge in each class. Also special topics that come up in the discussion of an assignment are given to pupils who volunteer to look them up in our library. The bulletin board is often used to attract us to further acquaintance with the library.

The list of books which follows includes all of the books which we have in our library, excluding textbooks of the conventional type. The short description is given wholly from the point of view of the uses of the book in an average high school group, so that a teacher may have some idea of a book's value to her class work:

ABBOTT, E. A.—*Flatland*—n. d. Little Brown. A popular treatment of the fourth dimension in fairy story form.

ARTHUR, JAMES—*Time and Its Measurement*, 1909, Chicago. Reprint from Popular Mechanics Magazine. A description of ancient and modern timepieces in popular style with beautiful illustrations.

AUERBACK, M.—*Graphic Mathematics*, 1910—Allyn and Bacon. A simple introduction to graphs.

BALL, W. W. R.—*Mathematical Recreations*, 1920—Macmillan. Best book on this subject in English. Pupils enjoy this book.

BOON, F. C.—*A Companion to Elementary School Mathematics*, 1924—Longmans Green Co. A useful historical outline and set of biographical notes at beginning. Eleven proofs of theorem of Pythagoras and a good chapter on nomenclature.

BRAGDON, C.—*Projective Ornament*, 1915—Manas Press, Rochester, N. Y. Shows use of fourth dimension and of magic squares in ornamentation, attractively illustrated.

BRECKENRIDGE, W. E.—*Shop Problems in Mathematics*—Ginn. Interesting applications of mathematics.

BRESLICH, E. R.—*First and Second Year Mathematics for Secondary Schools*, 1919, 1922. University of Chicago Press. Two new-type high school text books on correlating algebra and geometry.

CAJORI, FLORIAN—*History of Elementary Mathematics*, 1921—Macmillan. Simple introductory history.

COLUMBIA UNIVERSITY. TEACHERS COLLEGE. LINCOLN SCHOOL.—n. d. *Illustrated Mathematical Talks by Pupils of Lincoln School.* Interesting material prepared by pupils of junior high school age.

CONANT, L. L.—*The Number Concept*, 1923—Macmillan. Most useful part for high school pupils are the chapters on "Counting" and on "Origin of Number Words."

DAVIDSON, CHARLES—*Subjects for Mathematical Essays*, 1915—Macmillan. Suggestive for mathematical club discussions.

DUDENEY, H. E.—*Amusements in Mathematics*, 1917. Thomas Nelson and Sons. Another interesting recreation book with the puzzles and problems in one section and solutions in the other.

DUDENEY, H. E.—*The Canterbury Puzzles and Other Curious Puzzles*, 1929. Thomas Nelson and Sons. Includes the puzzles referred to in "The Canterbury Tales."

ESTILL, J. G.—*Numerical Problems in Plane Geometry*, 1918. Longmans Green Company. Many numerical exercises for teachers' use in extra assignments. College entrance examinations of period 1890-1900 included.

HEATH, SIR THOMAS—*History of Greek Mathematics, Vols. I and II*, 1921, Oxford Press. Best history of Greek mathematics in English. More extensive than Cajori's histories and more authoritative.

HUDSON, H. P.—*Ruler and Compasses*, 1916—Longmans Green Company. Rather advanced except for superior students of the high school age.

HOBSON, E. W.—*Squaring the Circle*, 1913—Cambridge University Press. Interesting account of this old problem. Teacher must direct pupil in much of the work in this book.

JONES, S. I.—*Mathematical Wrinkles for Teachers and Private Learners*, 1923—Samuel I. Jones, Nashville, Tennessee. Includes many

topics for recreation. Miscellaneous helps and quotations on mathematics gives material not quickly found in the histories.

JOURDAIN, P. E. B.—*Nature of Mathematics*, 1919. Thomas Nelson and Sons. Only the part on elementary mathematics within range of high school pupil's ability.

LAISANT, C. A.—*Mathematics*, 1913—Constable, London. Applications, recreations and discussions in rather easy style.

MANNING, H. P.—*Fourth Dimension*, 1921. Scientific American Publishing Co. Pupils get some light on the mysteries of the fourth dimension theory from the popular treatment.

MARSH, H. W. and MARSH, A. G. F.—*Constructive Text Book of Mathematics*, 1912—John Wiley and Sons. Popular with boys who have an interest in mechanics.

MARTIN, MARTHA EVANS—*The Friendly Stars*, 1907.—Harper and Bros. An attractive presentation of elementary astronomy without a loss of scientific accuracy.

MILLER, D. C.—*The Science of Musical Sounds*, 1916—Macmillan. On "Sound Analysis," with photographs of many types of harmonic analyzers and the sine and cosine curves representing various musical sounds. Trigonometry classes are fascinated with this book.

NUNN, T. P.—*Exercises in Algebra, Vols. I and II*, 1914. Longmans Green Company. By an English writer and teacher, this book furnishes exercises that are often unique in their approach to a topic.

OLCOTT, WILLIAM TYLER—*The Book of the Stars*, 1923—G. P. Putnam's Sons. Contains diagrams of all the important constellations. Legends of the stars are well told. Copies of many famous pictures from these myths are included.

ROW, T. S.—*Geometric Exercises in Paper Folding*, 1917—Open Court Pub. Co. Many of the exercises stimulate interest in the regular polygons and their lines. First 50 pages adapted to ability of plane geometry pupils.

SAXELBY, F. M.—*A Course in Practical Mathematics*, 1905—Longmans Green Company. Useful in work in applied mathematics and the sciences.

SCHUBERT, HERMANN—*Mathematical Essays*, 1917—Open Court Pub. Co. A well known book with best chapters on magic squares, fourth dimension and squaring the circle.

SCHULTZE, ARTHUR—*Graphic Algebra*, 1922—Macmillan. Part of this book can be used in third semester algebra while the remainder is more advanced.

SEDGWICK, TYLER—*A Short History of Science*, 1917—Macmillan. Has a good section on the history of mathematics.

SMITH, D. E.—*History of Mathematics—Vols. I and II*, 1923 and 1925. Ginn and Co. One volume is a general survey; the other a topical survey. Excellently organized, in a form attractive enough to interest young people.

SYKES, MABEL—*A Source Book of Problems in Geometry*, 1912—Allyn and Bacon. Largely construction and design work. Abundant material for assignments suited to individual ability. Results of these problems furnish bulletin board material.

WEEKS, RAYMOND—*Boys' Own Arithmetic*, 1924—Dutton. Story problems of algebra and arithmetic cleverly told. Pupils of all ages appreciate the dramatic and satirical values in this work.

WHITE, WM. F.—*A Scrapbook of Elementary Mathematics*, 1910—Open Court Pub. Co. Should be in every high school library. Much of interest in a very simple form.

As has been indicated in an earlier paragraph, there are many other ways to use the mathematics library besides in the assembly or club programs. To discuss this work in all

its phases in enough detail to be very suggestive to other teachers would require much more space than we can ask for at this time. A number of assembly programs are here recounted or briefly described. From these suggestions it is hoped that the interested teacher will be attracted by other opportunities to make mathematics less formal and more vivid.

A HIGH SCHOOL ASSEMBLY PROGRAM.

This program was given by a group from one of the sophomore geometry classes at University High School before the Mathematics Section of the State High School Conference in November, 1928. Twenty-two students took part; a student chairman presided and the program was given as if it were a meeting of a mathematics club. The material used, and topics presented, were all the result of student plans; the teacher having a very minor part, even in the planning of the program.

The secretary read the minutes of the last meeting of the club which included an interesting reference to the Club's motto; and listed the topics reported on at that meeting: "Ancient Clocks and Timepieces," "The Four Color Problem" and "The Cannibals and the Missionaries."

The program chairman announced topics for the next meeting which were: "String Figures, "Universal Puzzles," and "Match Tricks." After a consideration of several new items of business the program for the day was announced and the numbers given in the following order:

1. Magic Squares and Their Construction—Sophomore Girl. References: White, pp. 183-5; Ball, Chap. VII.
2. Magic Squares in Design—Sophomore Girl. Reference: Bragdon.
3. 64=65—Sophomore Boy. References: Ball, pp. 52-4; White, pp. 109-15.
4. Curious Problems—Sophomore Boy. Problems stated below.
5. Division Problems—Stunt by Three Girls.
6. Play: "Geometry Humanized"—by Geometry Class. Source: Mathematics Teacher, February, 1928.

In the first topic, "Magic Squares," the pupil explained how magic squares of odd and even order are made. She then gave a definite set of rules for odd order squares and with the help of the group, constructed a square of order five and one of order seven on the board. The other paper, "Magic Squares in Design," was discussed by a girl who

had made several lovely designs on large cardboards. She explained these to the group.

The curious problems talk included such questions as these:

1. If an iron band were fitted around the earth at the equator and it were cut so that a six foot piece could be inserted, so that the band was raised from the earth a uniform distance all the way around, could a man crawl underneath it? (Guesses are that it will be a fraction of an inch, or at most an inch. It is almost one foot.)
2. How much does a cork ball six feet in diameter weigh, if cork is known to be one fourth as heavy as water? (Guesses vary from 2 to 20 pounds, but the answer is nearly a ton.)
3. How much would $1 deposited at 3% interest compounded annually at the year 1 A. D. amount to by now?
4. An Arab sheik willed his camels to his sons so that the eldest would have one-half of them, his next son one-third and his youngest son one-ninth. When he died there were seventeen camels to be divided. How could this be done?

The stunt by three girls consisted of a number of questions such as, "Can you arrange us so we are divisible by 4?" or "Can we be divided by 8?" The girls were in gym suits and each wore a number, three, six, and one. In answer to the first question they stepped into the order 316, in answer to the second the arrangement was 136. After a series of questions came this one, "Are we divisible by 23?" After trying all the arrangements of the three numbers, the girl who wore the number six took her place between the other two and stood on her head so that the number 391 was formed.

The play was taken from the magazine cited and used with very few changes. The costumes of the geometric figures were large cardboard triangles and parallelograms, made of bright colored cardboard and lettered as suggested in the play. They were hung about the neck with a cord.

ANOTHER ASSEMBLY PROGRAM.

1. Development of Algebra Notation—Freshman Boy.
2. Interesting Stories from Mathematical History—Sophomore Girl.
3. Meeting of the Mathematics Association for Purpose of Improving Conditions in Uni High. Sketch written by two Sophomores.
4. Mathematics in Art and Architecture—Sophomore Girl.

The first paper on algebraic notation was developed from reading chapters on this subject in several histories and in the recreation books. The historical paper was largely biographical and discussed the lives of Archimedes, Euclid, Thales, Galileo, Newton, Fermat, Descartes, and others whose names we hear in geometry. The paper on art and

architecture used some material from Bragdon's book "Projective Ornament," and also discussed the Golden Mean or the division of a line in mean and extreme ratio as used in art.

The little sketch was written by a girl and a boy from a geometry class. It contained many bits of local color, and was received by the whole school group with great enthusiasm. The sketch is given in part.

ASSEMBLY SKETCH.

(Chairman comes in and seats himself at the table. Sophomores and a group of Seniors from the trigonometry class enter in groups of twos and threes. They carry their mathematical instruments, several huge blackboard protractors, three board compasses, a large pantagraph, a gravity protractor, two slide rulers, a large table of seven place logarithms, and yardsticks. Over the door is a large motto from Plato: "Let no one who is unacquainted with Geometry enter here.")

CHAIRMAN: This meeting was called for the purpose of discussing certain important improvements in mathematics in Uni High. I see that many of our best mathematicians have come to this meeting. Will you state the suggestions you have?

1ST SPEAKER: I suggest that π be changed to equal three. π has caused more trouble than any other one hundred things in mathematics classes. Just think how easy it would be to work with three. And then, too, three is a lucky number.

2ND SPEAKER: When we multiply by 3.1416, that can't be accurate because π really equals 3.141592+. And then, that still isn't accurate because π can be continued out forever and never end. So if we can't be really accurate, why all this bother. And think how easy it would be to never divide by 3.1416.

3RD SPEAKER: And, then the Bible says π equals three in two distinct places, one in First Kings VII, 23; the other is in Second Chronicles IV, 2. If we don't stick to the good old fashioned ideas of our fathers we may get into a lot of trouble. I think π should be kept equal to three.

4TH SPEAKER: I object! The reason they said π was equal to three in the Bible was because they didn't know any better. Moreover, think of all those poor mathematicians who have spent their lives figuring out the value of π. Shall their work be lost? Consider Archimedes, Ptolemy, Metius, Ceulen and then poor old William Shanks who worked it out to seven hundred and seven decimal places!

CHAIRMAN: Well, it seems to me that the only way to settle this is to vote on a motion. *(A motion was made from the floor.)* All in favor of making the value of π exactly three say aye.

ABOUT THREE-FOURTHS OF GROUP: Loud ayes.

CHAIRMAN: Opposed, the same.

A WEAK ONE-FOURTH: Aye, aye.

CHAIRMAN: How shall we go about the accomplishment of this movement?

5TH SPEAKER: I suggest that we appoint a committee of prominent politicians and mathematicians from Uni High to go to Springfield to get a bill introduced into the legislature.

6TH SPEAKER: A very good idea! If they can pass a law against evolution in Tennessee, I'm certain we can pass a bill changing the value of π in Illinois.

CHAIRMAN: Who are the prominent politicians from Uni High?

1ST SPEAKER: I suggest some people with the gift of gab. I pro-

pose these names—*(four of the notably quiet and reserved upperclassmen were named).*

2ND SPEAKER: We need to include on the committee the dignified people—*(here the names of the liveliest and most disturbing pupils in study hall were given).*

5TH SPEAKER: And we must send Mr. A. along. He'd enjoy the trip so much. *(Mr. A. was a favorite teacher of civics and American History.)*

2ND SPEAKER: I move that the people named represent us.

(The motion is put by the chairman, and carried.)

CHAIRMAN: Is there other business? *(A boy rushes in and accosts another boy who is impersonating Mr. W., our principal.)*

7TH SPEAKER: Good morning, Mr. W. When are you going to pay your coal bill? You owe me $91.

MR. W.: How's that?

7TH SPEAKER: You bought 13 tons of coal at $7 per ton, which is $91.

MR. W.: But that is only $28.

7TH SPEAKER: How can that be? Here is the bill—it says $91.

MR. W.: I'll prove it to you. Here it is by multiplication.

(Mr. W. goes to the board and writes:

$$\begin{array}{r} 13 \\ 7 \\ \hline 21 \\ 7 \\ \hline 28 \end{array}$$

and says: 7×3 is 21 and 7×1 is 7. $21+7$ is 28)

7TH SPEAKER: I don't believe it.

MR. W.: Then let's add it.

(He writes down the seven 13's in a column. He adds the threes in the right columns and gets 21, then he goes on up the left column 22, 23, 24, etc., to 28.)

7TH SPEAKER: I don't believe it yet.

MR. W.: Well let's see by division.

(writes:

$$\begin{array}{r|l} 3 & \\ \hline 7 & 28 \\ 21 & \\ \hline 7 & \end{array} \qquad \begin{array}{r|l} 13 & \\ \hline 7 & 28 \\ 21 & \\ \hline 7 & \\ 7 & \\ \hline & \end{array}$$

He does the first by saying 7 will go 3 times with a remainder of 7. 7 goes into 7 once and then he deftly places the one in front of the 3.)

7TH SPEAKER: Well, I guess you're right.

MR. W.: Here's your $28. Is that right?

GROUP: Of course, it's right. Mr. W. is usually right. *(They have been computing on slide rules, by logs, etc., through this discussion.)*

CHAIRMAN: Is there other business?

8TH SPEAKER: Yes, I've just worked out a legitimate method of getting out of work. Let me show you how simple it is: There are 365 days in the year except in Leap Year. If one should spend eight hours out of twenty-four in sleep it is equal to 122 days of the year. If one takes the proper amount of recreation, eight hours a day or 122 days a year are gone, and so 121 days are now left. If one remembers that July 4, January 1, December 25, May 30 are holidays, only 117 days are left. Usually one is allowed two weeks vacation

on salary so taking out 14 days there, only 103 days remain. There are 52 Sundays, and Saturday half holidays take 26 days; after subtracting these two items 25 days remain. If meals are to take an hour-and-a-half or there about each day then 24 days are required for meals which leaves one day. That day is Labor Day and no one works on Labor Day. So when do we work? Figures never lie.*

CHAIRMAN: Yes, but liars sometimes figure. But shall we adopt this schedule for work?

ALL: (Yes, yes.

(A large group of Freshmen appear at the door.)

FRESHMAN LEADER: We hear that an assembly of mathematicians is in session and we ask if we may come in and propose some perplexing and important problems.

CHAIRMAN: These Freshmen do not know geometry but shall we set aside our motto and admit them?

ALL: Yes.

(The Freshmen enter and present their problems, some very funny, clever ones from Week's book, "Boys' Own Arithmetic." After each problem some one by the aid of his tools gets an answer and states it, always a very irrelevant answer but everyone nods agreement.)

CHAIRMAN: If you are all agreed on these solutions shall we adjourn?

(Motion made for adjournment.)

A MORE RECENT PROGRAM.

A very novel assembly was given this spring under the direction of Miss Gertrude Hendrix of the Mathematics Department, University High.

The unifying idea was that of a radio program. The announcer was present at the side front of the stage, thruout the program, and was a great factor in the success of the program with his clever flow of remarks. The station was F-U-N.

A dance was given by some girls from Algebra I. They wore letters for formulas, A. V. l, w, h, n̄, r, exponent 2, etc. The equal sign was the leader and she arranged various formulas, stepping into her place to complete the formula each time. The dance steps were simple but cleverly executed.

Mathematical words such as "substitution," "root" and "cosine" were illustrated by posters, the audience guessing the words. Suggestions for this may be found in the "Mathematics Teacher," 1927, Volume, p. 275.

A play taken from a magazine was given also. A song written by a pupil and sung by four boys is given on the following page.

From the descriptions given, it is easily seen that the op-

*This idea is not original with us. But we could not find the original figures so we wrote it as given above.

portunities and possibilities are almost unlimited, if one has available a few books on recreations, and is interested in arousing enthusiasm for mathematics. A number of original sketches, a very clever historical pantomime, some poems written by pupils, come to mind even now as parts of programs we have written and given, which I have failed to recount here. If the organization can be a bit original, the pupils will enjoy the program much more, and we shall feel that we are not teaching formal mathematics to inert pupils but are teaching a very worth while and alive subject to the liveliest group of youngsters in the world!

IF THERE WERE NO MATHEMATICS AT ALL.
(Tune: If I Had a Talking Picture.)

If there were no mathematics
To do———
There would be no algebra problems
For you———
We could play our time away
And with no E's have to pay
But what would we do
When we were all through——
There would be no automobiles—no
And the radio—It would not
Go——
It would not be so much fun
As we thought it ought to be
For our mothers could get no cooking done!

But we have our mathematics
What must we do——
Work all of our problems each day
Clear through—yes.
When the trig proofs seem so queer
And the time gets oh so dear,
Think of all those things which you could never do—
Pies and cakes taste good to me—(oooh)
How 'bout you?
It makes my poor 'tummy ache, I'm blue—
Why we could not even sing
Or count a single thing—(not even pennies)
If we had no mathematics at all.

NOTE: Since this article was written, a new book has come to my desk. "The Teaching of Mathematics in Secondary Schools, Vol. I, Technique," by Ernst R. Breslich. The bibliographies on pp. 82, 85, 86 are excellent on recreational material.

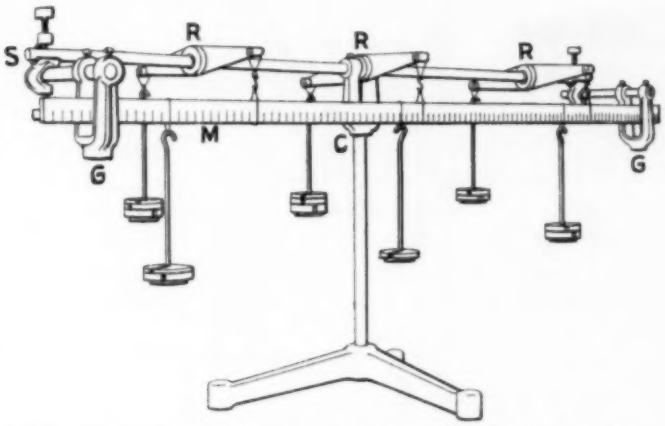
The largest single order ever received by the U. S. Department of Agriculture from a foreign government for agricultural movies has just come from Uruguay. The request is for 136 of the Department's educational films and it is urged that they be sent as soon as possible.

TWO LABORATORY EXPERIMENTS ON THE EQUILIBRIUM OF TORQUES

By MILES J. MARTIN,

University of Wisconsin, University Extension Division.

This article describes two laboratory experiments for demonstrating the equilibrium of torques which possess certain unique features. Apparatus of similar type has been in use in the physical laboratories of the University of Wisconsin for several years. Certain refinements of design and construction have merely been introduced into this apparatus.



The "moments bar" illustrated in Figure 1 is an arrangement for illustrating the equilibrium of torques when the forces are both coplanar and parallel. The chief advantage of this apparatus over other types commonly used for such experiments is that it provides for the application of upward forces as well as downward forces. The apparatus thus lends itself conveniently to the study of couples. It consists essentially of a uniform graduated bar, M, supported in the guides, G. By means of the rocker arms, R, upward forces may be applied to the bar. The center rocker arm is fixed in position and serves as a means of counterpoising the bar. The other two rocker arms may be placed at any positions on the shaft, S, which also carries the guides, G. These guides and the center support clamp, C, are simply cast iron clamps in the form of a U. The rocker arms are aluminum castings into which brass bushings have been fitted to act as bearings. An ordinary meter stick

serves as the bar to which the rocker arms and scale pans are attached by light loops of string. The average experimental error with this apparatus is less than 1 per cent.

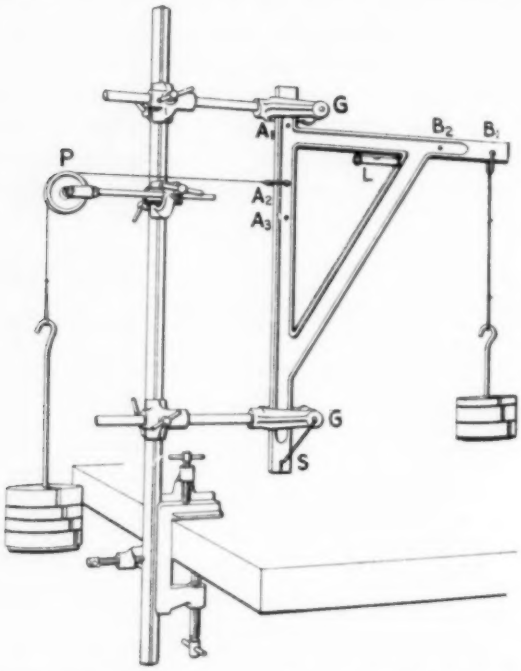


Figure 2 illustrates an apparatus for experimenting with torques in which the forces are coplanar but not parallel. It consists of a simple fixed-arm derrick mounted in the guides, G. The load consists of a vertical force applied at either of the positions B_1 or B_2, and the horizontal effort force may be applied at any point A_1, A_2, A_3. The derrick is supported at its base by a stirrup, S, which serves as a pivot, and which indicates by its position the direction of the force reaction at the pivot. The direction and magnitude of this reaction may be gotten from the vector polygon of forces and compared with the observed value. A small spirit level, L, facilitates the adjustment of the derrick in a vertical position. The guides, G, are made from the same castings as those used on the moments bar. The derrick is an aluminum casting one inch thick and twenty inches by sixteen inches over all. It may be easily removed from its supports for weighing and measuring. A variety of

instructive experiments may be performed with this apparatus with an average error between 1 and 2 per cent.

Both of these pieces are very rugged in construction and yet capable of yielding precise results in the hands of the careful student. They can be completely dismantled and stored in small space which is a factor to be appreciated in the average laboratory. They can be readily constructed at very low cost. Accessories such as support rods, clamps, and pulleys are of the type commonly used in the laboratory.

VELOCITY OF TRANSVERSE VIBRATIONS IN STRINGS.

By F. M. DENTON,

The University of New Mexico, Albuquerque, N. Mex.

Many text-books of Physics state the formula $V = \sqrt{F/m}$ without proof, remarking that the proof may be found in more advanced works. A few books, intended for University use, give the ingenious proof of Professor Tait in which the vibrating string is thought of as passing through a bent tube.

I have worked out the following proof which, though brief, non-mathematical and, I believe, sound, appears to be unknown.

Let AB be a uniform flexible string stretched by a force of F dynes between end posts A and B. Let m be the mass of the string per centimeter of its length.

Experiment shows that any small transverse distortion imparted to the string travels along it with uniform velocity. It is required to show that this velocity is $V = \sqrt{F/m}$.

Proof:—Let the string be distorted at A into the shape ACB by being pressed up against the post for a short distance AC. On releasing the pressure at C the kink moves with uniform velocity V along the string towards B.

We may regard the force F as causing this motion, and using Newton's definition of Force, $F = AM$, may write:

$$Force = \begin{pmatrix} Velocity\ given\ to\ a\ mass \\ in\ one\ second \end{pmatrix} \times \begin{pmatrix} Mass\ to\ which\ that \\ velocity\ is\ given \end{pmatrix}$$

It is the "kink" to which velocity is being given and *the mass constituting the kink suffers continual renewal at the rate* (mV) *grams per second.* Thus *the mass to which velocity* V *is imparted in each second is* mV, and in the formula $F = AM$ we have $A = V$ and $M = mV$, whence $F = V(mV) = mV^2$ and $V = \sqrt{F/m}$.

A STANDARDIZED TEST IN BIOLOGY.[1]

By J. L. Cooprider,

Central High School, Evansville, Ind.

Some Difficulties in making a Biology Test. The maker of an educational or achievement test in general biology for use in high school is confronted from all angles with the lack of standardization. The subject matter of the texts in the subject is not standard. No two authors of texts seem to have the same goal in mind when they write their books. Some seem to be more or less one sided and place emphasis more upon the botany of biology or the zoology of biology or upon human biology rather than upon general biology. Some emphasize facts, others major ideas or biological principles. Many wish to intercorrelate these phases of biological materials for the purpose of arousing interest in biological nature-study or to aid the boy and girl in the interpretation of the biological phenomena about them in relation to human welfare. A few still think that the purpose of biology teaching is to develop embryo-biologists who will later go to college where they will mature into adult biologists.

Methods of presentation are not standard. Some prefer the individual method to the demonstration and vice versa. The plant and animal materials used by different schools in different localities is similar but not uniform. There are as many different kinds of laboratory equipment as there are different schools. Courses of study, if such are in actual usage, vary with the supposed "needs and desires" of local schools.

Historical. In 1920 the author began a survey of the vocabularies of the textbooks then published in high school biology. As a result of this survey, a preliminary test form was constructed and given during a period of two years to about 350 students in general biology in high school. When this trial test was first given it contained 300 questions. After each administration, some of these 300 questions were revised, some were canceled and some were added. Questions missed by all students were considered too difficult and those missed by no student were considered too easy and both were dropped. Ambiguous questions were discovered and reshaped.

In 1922 a second survey of the vocabularies of textbooks was made. This survey was added to that made earlier, making a total of nine texts that were analyzed. After this analysis the

[1]Published by The Public School Publishing Company, Bloomington, Illinois, under the title "Information Exercises in Biology." Sample copies may be had for ten cents.

test was again revised. An attempt was made to exclude as far as possible all biological terms that were not found in all of the nine texts, also to exclude all parts of the test that were otherwise less valid. After this revision the test was reduced to 100 fairly well selected questions. These were divided into six exercises of about the same number of points each. The vocabulary of these questions was found to contain 226 different biological terms, 83% of which was found in all nine of the textbooks surveyed; 86% in 8; 90% in 7; 93% in 6; 96% in 5; 100% in 4. Another analysis showed that 38% of all the questions pertained to animal biology, 27% pertained to plant biology; 18% pertained to the field of human biology; and, 17% were of general nature.

The author has emphasized the informational and factual side of the subject and he has not attempted to measure attitude or interest. There are other factors, however, which enter into the test. The information involved in some cases demand a knowledge of general biological laws, principles, concepts, fundamental processes, or definitions. Some questions demand a knowledge of function, structure, and classification of organisms. Problems are presented relating to health, environment, interrelation of organisms, evolution, life history, and habitats. Although this test has stood for ten years, it seems advisable to devise tests that will measure attitudes, interests, and principles more adequately. There is also a need for tests that will take inventory, since there is much overlapping in the sciences and since there are many agencies, outside the school, which contribute to the students' knowledge of biology before he comes to the biology class.

ADMINISTRATION OF THE TEST. In the construction of the test special attention was given to simplicity and convenience of administration. The examiner need not be an expert in giving tests. It is possible for anyone to master the directions for giving the test in a few minutes since these are few and simple. Directions to pupils for each exercise are short and easily understood by the pupil, and they are not read or discussed by the examiner thus reducing the personal equation to the minimum.

The length of the exercises makes it possible to administer the test in a regular 40 minute period. There is no time limit. The slowest pupils seldom require more than 40 minutes and most students are done in 25 to 30 minutes. Students, who use more than 40 minutes or less than 15 minutes, need special investiga-

tion, and, in a large number of cases they will be found to be wasting their time or have not done the exercises as directed.

There being no time limit, neither the questions in each exercise nor the exercises themselves were arranged in order of difficulty. The author believes that scaling a test would be of value when there is a time limit and that a time limit would place an unnecessary handicap on the students. In a test of this sort it seems to the author that a student should have all the time he needs to attempt all the questions, since such tests should attempt to determine the power of the student rather than his speed.

SCORING. In three exercises of the test students are asked to draw a line through one word that indicates the correct answer. This makes it possible for a stencil to be used in scoring. This stencil may be cut from one of the test forms by the use of a sharp knife or razor blade so as to leave holes at the places which show the correct answers. When the stencil thus cut is placed over a paper the correct answers may be seen at a glance and the correct score recorded very quickly. In two exercises the questions are so arranged that the correct answers have key which is easily learned by the marker. For example, in Exercise 4 which is a "Best Reason" test, there are four possible ways of answering the question, each possible answer being numbered 1, 2, 3, and 4. The correct answer to the first question is number 2, for the second question it is number 4, for the third question it is 1, and for the fourth question it is 3. So the key for this exercise goes like this—2, 4, 1, 3, 2, 4, 1, 3, 2.

In all of the exercises of the test the score is the number correct except in Exercise 4 in which the score is twice the number correct. One exercise is of the true-false type, but the score for this exercise is the number right. The author believed that the R-W method of scoring is of poor diagnostic value. A student may know 50% of his subject matter and still make a negative score if the score is the number right minus the number wrong. All zero scores look alike. The author has in mind a large number of students, who at the beginning of the year in biology, got but two of the sixteen questions correct, and, who at the end of the semester or mid-year got seven or eight questions correct, but in both cases the score would be zero under the R-W method of scoring. If a student misses almost all of such questions at the beginning of the course, and then if he can answer one-half of them at the mid-year, it seems that he has added to

his knowledge of the subject, and that he should be given credit for the number he gets right.

THE SCORES. Although several thousand copies of the test have been sold throughout the country, it is very difficult to have results reported. To date the standards are based upon the results of 3096 students who have taken the test in its present form. The averages given in the table below indicates the present standards. Additional scores do not seem to alter the averages.

Average Scores based upon 3,096 cases.

Amount of biology	Mean score	Median score	S. D.	P. E.
None	28.748	28.870	8.060	1.080
Mid-year	45.867	45.810	10.490	1.415
One year	53.916	55.585	10.725	1.450

There were 160 of these students who had the test administered to them a second time in two consecutive days. The coefficient of reliability according to Brown's formula is .92, which seems to be exceptionally high. The correlation of the scores of these same 160 students with their teachers' estimates is .70, which again is fairly high.

In an unpublished paper, Mr. J. C. Mayfield, University High School, Chicago, has made some very interesting studies of this test. With his permission, I am giving one of his tables below, as well as copying his comments.

"The correlations of all the scores on each exercise with every other exercise and with the total scores were computed. The results are given in the table above. Two significant facts are brought out by this comparison. The most important one, as far as the test is concerned, is the high correlations of the total score with the various exercises. The mean here is .643 while the mean correlation of Exercise 5, the next highest is .515. This is taken as an indication that the final score on the test is a more reliable measure than the score on any one exercise.

"The second fact which is observed is the low mean correlation of Exercise 4 which is .283. This would indicate that Exercise 4 is measuring something different from the other exercises. Further study would be necessary to determine what this difference really is.

"Practically no correlation was found between the time used and the complete score."

Correlations found in 43 cases in Cooprider Information Exercises in Biology.

Exercise No.	1	2	3	4	5	6	Total Score
1. Completion	....	.126	.489	.237	.424	.208	.618
2. True-False	.126	.....	.446	.273	.360	.390	.585
3. Information	.489	.446	.....	.252	.589	.400	.785
4. Best Answer	.237	.273	.252	.....	.291	.090	.554
5. Classification	.424	.360	.589	.291	.....	.448	.777
6. Logical Selection	.208	.390	.400	.090	.448	.....	.539
Total Score	.618	.585	.785	.554	.777	.539	.....
Mean Correlation with all other scores	.350	.347	.494	.283	.515	.346	.643
Correlation of Total Score and Time Used = .124							

In the next table are given the correlations of the Information Exercises in Biology with the New York Regents Examinations. Since these are the only cases reported they are subject to changes Scores and Regents were furnished by Miss Mildred A. Hepburn. According to Rugg[2] correlations of 35 to 60 are "high," and according to McCall[3] a correlation of $\pm.4$ to $\pm.7$ is "substantial." The author welcomes the two above reports and hopes that others will report similar findings.

The validity, reliability, and correlation outweigh the value of standards as to usefulness. The writer is more or less pessimistic as to the value of norms secured from a large number of schools. There is a marked difference in scores secured from different states, cities, and even schools within the same city. Securing norms from large numbers should not be discouraged but these seem to be of such little value when applied to a single group. It seems to be far more important to obtain a relatively fair

[2]Rugg, H. O., Statistical Methods Applied to Education, p. 256.
[3]McCall, W. A., How To Measure in Education, p. 393.

Correlations Found in 81 cases in Information Exercises in Biology with New York Regents Examinations.

No. of cases	Mean score Inf. Exer.	Mean Regents Exam.	Correlation
33	45.4	73.6	41.35
25	42.6	73.2	55.46
23	49.3	67.1	40.13

ranking of the students of one school than it is to make comparisons between students of one school with other schools in different localities where methods, materials and other procedures are different.

VALUE OF THE TEST. The test has been found to be very helpful in furnishing—

1. A quick means of securing a reliable and objective mark or score to supplement the judgment of the teacher in making promotions. The user of any test should never be blinded by the test results themselves however perfected the test may be, and base marks wholly upon one test. There are other objectives in biology that we must not lose sight of, namely, spirit of investigation, appreciation of nature, scientific habits, increase of love of home, friends, and state, respect for laws, both of state and nature, etc. We have no objective test of these things.

2. A quick way of arriving at the probable biological information of classes at the beginning of the year and at midyear. This information could be used as an aid in a more scientific classification of pupils. However, this test should not be used alone as a basis of classification. The result of any one educational or mental test or performance is not sufficient evidence to secure the class rank, but rather more than one measure together with teachers' judgments should be used.

3. A good check on the progress made during the course. The progress made by students should aid in the determination of promotions, failures, and classifications as much as the extent of the biological information of the student. A student may have a large range of biological information at the beginning of the year, and his progress may be marked or not noticeable. A poor student may have a small range of information at the end of the course and a smaller range at the beginning. The score of this poor student at the end of the course may be less

than that of the stronger student at the beginning of the course. But the progress of this poor student may exceed that of the better student by several points. The author often makes a frequency table of the progress of students as shown by the scores of the test and the beginning and end of a grading period and used this alone with other frequency tables and other data in determining the success of his students.

FROM THE SCRAPBOOK OF A TEACHER OF SCIENCE.

By Duane Roller,
The University of Oklahoma, Norman, Okla.

Nearly every physical definition, rightly understood, is an actual physical operation.—*Franklin & MacNutt, "Mechanics and Heat."*

We obtain our knowledge of forces by having some theory about masses, and our knowledge about masses by having some theory about forces.—*A. N. Whitehead in "An Inquiry Concerning the Principles of Natural Knowledge."*

The science of mechanics does not comprise the foundations, no, nor even a part, of the world, but only an *aspect* of it.—*Ernst Mach in "The Science of Mechanics."*

Nature tosses her creatures out of nothingness, and tells them neither whence they came nor whither they go. It is their business to run—she knows the road.—*Goethe.*

I labor much less to catch the suffrages of the public than to obtain that inward approval which has always been the sweetest reward of my efforts.—*Extract from a letter written by Fresnel to Thomas Young in 1824, and quoted by John Tyndall in "Lectures on Light."*

The teacher will observe that those parts of mechanics which a beginner usually finds "hard to learn" are the parts which, in the development of the science, were difficult to overcome. Take, for instance, the difference between force and energy, or the concept of mass.—*Florian Cajori in "A History of Physics."*

I would feel more content that the universe undergo some great scheme of evolution and, having achieved whatever may be achieved, lapse back into chaotic changelessness, than that its purpose should be banalised by continual repetition. I am an Evolutionist, not a Multiplicationist. It seems rather stupid to keep doing the same thing over and over again.—*A. S. Eddington in "The Nature of the Physical World."*

Where neither confirmation nor refutation is possible, science is not concerned. Science acts and only acts in the domain of *uncompleted* experience.—*Ernst Mach, "Science of Mechanics."*

The great *desideratum* for any science is its reduction to the smallest number of dominating principles.—*J. Clerk Maxwell in "Matter and Motion." Henry Crew says that no student of physics can afford not to own this volume.*

THE SLIDE-RULE IN THE JUNIOR HIGH SCHOOL.

By CHARLES A. STONE,

School of Education, The University of Chicago.

During the past few years teachers of Physics and Chemistry have complained that their subject matter has been constantly growing, but that no provision has been made to equip the pupil to handle adequately the additional calculations necessitated by this growth. Thus many teachers advocate the teaching of the slide-rule to students before they commence the study of either Physics or Chemistry in order to facilitate the solution of problems and to permit the handling of many more than is ordinarily possible with tedious methods of calculating. As a result of this agitation many schools have introduced this instrument, and the enthusiasm with which it has been received by the students has been so great that no doubt it will soon be used in every college and secondary school in the country.

At the present time the slide-rule is not only finding use in science classes and in the engineering profession, but it is being used extensively in all phases of business transactions. To the business man time means money, and the slide-rule is the instrument that he uses to save time in his calculations. Sometime ago S. L. Shelby of the Babson Statistical Organization in discussing the attitude of the average business man toward mathematics stated that the business man urged the teaching of the slide-rule to the pupil so that in the future he might save his own time as well as that of his employer in performing the numberless calculations that arise in the transactions of business.

Since the Junior High School aims to train the pupil to meet the needs of every-day life, the question that arises at this point is "Why not teach the pupil in the Junior High School how to use a slide-rule and thus prepare him for those activities in which he will engage in the near future?" Certainly the slide-rule is one of the most practical applications of his mathematics. Many teachers have answered this question by stating that the slide-rule is an instrument based on logarithms and hence it is impossible to teach its use without a knowledge of logarithms. Although it is true that the slide-rule is a logarithmic scale,

a knowledge of logarithms is not essential before one can learn to use the instrument efficiently. Seventh year pupils can be taught to operate the slide-rule with speed and accuracy without rationalizing the process in much the same way that elementary school pupils are taught to multiply and divide fractions without rationalization. The slide-rule is a scale, and pupils can be taught to use it just as they are taught to use any other scale. Thus there is no reason why the slide-rule should not become an impor-

A SLIDE RULE CLASS CONSISTING OF CHICAGO JUNIOR HIGH SCHOOL TEACHERS.

tant factor in the mathematics of the Junior High School.

Aside from the fact that the slide-rule will save for the pupil considerable time and energy in his calculations, it can help him in approximating and checking results. Both the business man and the technical man find it to be exceedingly useful in checking results. Thus there is no reason why the Junior High School pupil should not use the slide-rule for a similar purpose. Furthermore he should find it to be an extremely valuable asset since the problems found in the present day texts are usually related to every day life. It should be understood, of course, that the slide-rule is not accurate beyond three or possibly four figures. However, the mathematics of the Junior High School involves computations that do not require greater than three or four figure accuracy. Even if the pupil developed nothing more than the habit of approximating and checking results through the use of the slide-rule, the time and effort spent in learning to use the instrument would be

worth while. Therefore the use of the slide-rule can be justified as a part of the course of study.

In his contacts with those who have failed in their attempt to learn how to use the slide-rule, the writer discovered that failure was due to inability to read the various scales with facility. This is not surprising when one examines the manuals and direction books now in existence and finds but little space devoted to the discussion of how to read the scales on a slide-rule. Since ability to read the scales plays such an important part in making for success in operating the rule, the writer feels that he is justified in devoting a little space to an effective method of teaching pupils how to read the scales.[1]

As previously pointed out the slide-rule consists of a number of scales which can be easily taught to the pupil just as any other scale is taught. The pupils can be shown that the scales on the slide-rule resemble in certain respects the scale on a metric ruler, Fig. 1. The large divisions on

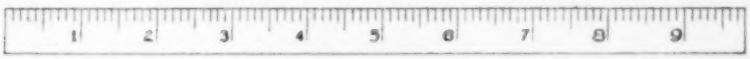


FIG. 1

the metric scale are subdivided, first into halves, and then into tenths, each half being divided into five equal parts. The large divisions are centimeters and the smallest divisions are millimeters. The difference between the slide-rule scales and the metric scale is that on the metric scale the divisions are equal, while on the scales of the slide-rule they are unequal, Fig. 2. This scale represents a scale of

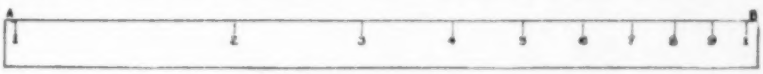


FIG. 2

one figure numbers. The pupil can now be shown that the space between 1 and 2 is subdivided as shown in Fig. 3,

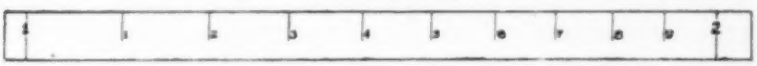


FIG. 3

[1]For a complete discussion of the construction of a slide-rule and of the reading of the scales, the reader is referred to "The Slide Rule" by Breslich and Stone, The University of Chicago Press.

and that the small numbers on the scale are read 1.1, 1.2, 1.3, etc. In the same way the spaces between 2 and 3, 3 and 4, etc., are subdivided to give a scale of two figure numbers. The spaces between 1 and 1.1, 1.1 and 1.2, etc., are again subdivided to give (Fig. 4) a scale of three figure numbers.

FIG. 4

The pupils may now be taught to read numbers between the index 1 and the number 2. A diagram like that shown in Figure 5 is exceedingly helpful in showing pupils how to read numbers on any of the four slide-rule scales A, B, C and D. Thus in Figure 5, the first large division is read 1.1, 11, 110, 1,100, etc. Similarily the second large division from the index 1 may be read 1.2, 12, 120, 1,200, etc. This

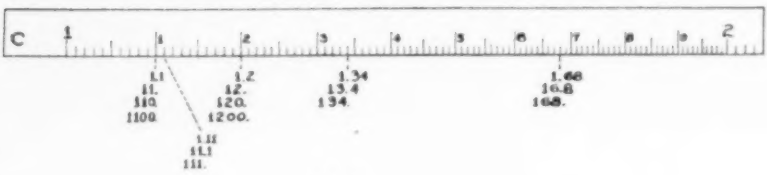


FIG. 5

process is carried out for all of the divisions and the pupils are then given many numbers to locate on the scales A, B, C and D. After the pupil has mastered the reading of numbers in the scales the teaching of the operations becomes a simple matter. The writer has used the above technique with a great number of pupils in the Junior High Schools of Chicago, and has found it very successful with all types of pupils.

In spite of the fact that the National Committee on Mathematical Requirements has recommended the use of the slide-rule in Junior and Senior High Schools, and that courses of study include the slide-rule, teachers sometimes find it difficult to allot sufficient time for instruction during regular class periods. In order that pupils may not be deprived of the opportunity to study this valuable instrument many schools encourage the formation of slide-rule clubs which meet regularly once a week as is the custom with the other Junior High School Clubs.

These clubs usually meet under the supervision of the instructor, although when some superior pupil shows particular ability in its use, he may be chosen as the chairman to direct the club activities. It may be further stated that the slide-rule club does not prove a burden to the teacher in the way of planning programs from week to week as is usually the case in club activities.

A SLIDE RULE CLASS AT THE ROGER SULLIVAN JUNIOR HIGH SCHOOL, CHICAGO, ILL.

In aiding teachers to organize slide-rule clubs the writer has usually given the first two lectures. The first lecture comprises a discussion of the use of the slide-rule in the various walks of life, and a demonstration of its use in solving many practical problems. This acts as a stimulus to the pupils and it arouses their interest to such an extent that they eagerly await the second meeting. Teachers in any locality can usually obtain lecturers by writing to the manufacturers of slide-rules.

The second meeting is devoted to a discussion of the construction of the slide-rule, and to the teaching of the reading of numbers in the various scales. For the remaining meetings the program would be as follows:

Meeting 3: Simple multiplication and division.

Meeting 4: Combined multiplication and division.

Meeting 5: Application of multiplication and division to practical problems; physics, chemistry, shop problems, etc.

Meeting 6: Finding squares, square roots and cube roots.

Meeting 7: Proportion and its application to practical problems in chemistry, physics.

Meeting 8: Percentages—as a proportion problem in chemistry and physics, in accounting, in cost distribution, etc.

Meeting 9: The use of the A and B scales.

Meeting 10: The use of the sine scale, working simple problems in trigonometry involving the sine and cosine.

Meeting 11: The use of the tangent scale. Working simple problems involving tangents and cotangents.

Meeting 12: Simple surverying problems.

Meeting 13 and 14: Demonstrations of special settings by pupils who have devoted considerable time to the study of the rule.

Meeting 15 and 16: A slide-rule contest involving speed and accuracy.

Meeting 17 and 18: Lectures and demonstrations by experts on the slide-rule.

The above program may be either shortened or lengthened to meet the convenience of the teacher and the school.

In conclusion it can be stated that pupils are eager to join slide-rule clubs because of the novelty involved in manipulating a slide-rule and the ease in making required computations that by other methods would convert a pleasant recreation into a tedious and burdensome task. Every student of course should own his own slide-rule[2] and should be taught to care for it as he would any other valuable tool or instrument.

[2]The Keuffel & Esser Co., Chicago, Ill., now manufactures a beginners' slide rule that is well made and is reasonable in price for the Junior High School pupil.

WIDIA.

German metallurgists have perfected a new alloy, called "widia." It is nearly as hard as diamond. Though still worth more than its weight in gold, it should be of high commercial value in making tools for cutting or filing other metals. Widia is an alloy of tungsten, carbon, and cobalt.

How a combination of three different substances can be so much harder than any one of them alone cannot be explained in a few words. Such a difference may exist between forms of the same substance, as carbon, for example. Chemically, diamond and graphite are both carbon, yet they are quite different in physical properties;—that is, they differ markedly in appearance, hardness, etc.

Steel is a common alloy which is harder than either of its components, iron and carbon. An alloy is a substance composed of two or more metals, or metals and non-metals. Brass is also a common alloy; it is a combination of copper and zinc.

AN EXPERIMENT ILLUSTRATING THE CHANGE IN THE RATIO OF OXYGEN TO CARBON DIOXIDE DURING THE EXPIRATION OF AIR FROM THE LUNGS.

BY HERBERT J. ARNOLD,

Lincoln School, Teachers College, Columbia University.

The percentages of the different gases in fresh air are commonly given as follows:

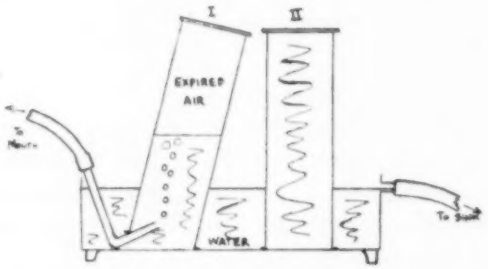
Nitrogen (and argon)	79. %
Oxygen	20.96%
Carbon dioxide	.04%

After air has been taken into the lungs its oxygen content is decreased and its carbon dioxide content increased, so that when it is breathed out the percentages[1] are:

Nitrogen (and argon)	79 %
Oxygen	16.02%
Carbon dioxide	4.38%

The percentages of oxygen and carbon dioxide, however, do not remain constant while the air is being expelled from the lungs. During the first part of the expiration the percentages of these two gases are not different from those of ordinary fresh air. As the expiration of the air continues, the percentage of the oxygen decreases and that of the carbon dioxide increases. If the person who is breathing makes an effort and expels some of the reserve, or supplemental, air from the lungs, the percentage of carbon dioxide becomes greater than the value given above.

This may be shown very simply by the following experiment:

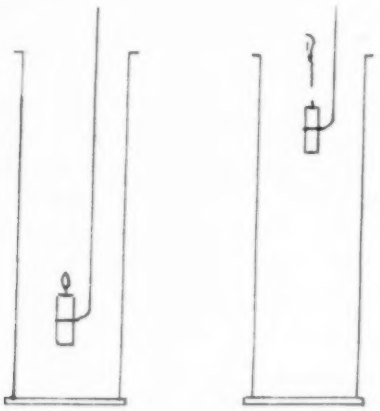


Two glass cylinders are filled with water and inverted in a pneumatic trough, as shown in the accompanying diagram. The cylinders are of the type frequently used in the

[1] Howell, W. H. "A Textbook of Physiology." Eighth Edition. W. B. Saunders Co.

collection of gases by the displacement of water; they are about fifteen inches tall, three inches in inside diameter, and have a capacity of about 1750 cc. (Their number in the L. E. Knott Chemistry Catalogue is *c6400i.*) Some one now blows through a rubber tube and displaces the water in both jars with air from his lungs *using but one expiration for the process.* This may be done by the average junior high school boy; the teacher probably can fill more than two such cylinders with one breath.

The open ends of the jars are covered with glass plates, the jars are withdrawn from the trough, and they are set upright. A lighted candle at the end of a wire is now inserted into each jar. The candle burns brightly even at the bottom of the first jar; while in the second jar the flame goes out before it has been lowered more than three or four inches into the jar.



A candle flame goes out when the proportion of oxygen has fallen to 16.5 per cent.[2] Therefore the percentage of oxygen in the first part of the exhaled air was *greater* than 16.5% while the percentage of oxygen in the last part of this air was *less* than 16.5%.

The reason for this change in the percentages of oxygen and carbon dioxide as the air is breathed out is quite evident. The air in the first jar was that which, when inhaled, got no farther than the mouth, pharynx, larynx,

[2]Kendall, James "Smith's College Chemistry." Century Co.

trachea, or bronchial tubes. Since no interchange of oxygen and carbon dioxide takes place in these parts of the respiratory system, the percentages of gases in the first part of the expired air are practically the same as the percentages in the fresh air. It is only when some of the air which has been in the *alveoli*, or tiny lung sacs, is expelled, that the amount of carbon dioxide begins to increase and that of the oxygen to decrease.

Deep breathing is a valuable exercise for the muscles of the chest and, it is evident from this experiment, that it is of further value in that it removes more carbon dioxide from the lungs and makes more oxygen available to the blood, than would be the case if the breathing were shallow.

A THREE-YEAR COURSE IN GENERAL SCIENCE

By HATTIE E. REICH,

Senior High School, Springfield, Mo.

"A pirate who buried his treasure chest"; "another kind of treasure chest"; "our own compartment of the treasure chest"—no, these are not titles gathered from Ali Baba and the Forty Thieves or the Adventures of Captain Kidd, but equally interesting and stimulating problems selected at random from a new course of study in science prepared by a committee of Springfield, Missouri, Junior and Senior High School science teachers.

After an exhaustive study of the latest curricular investigations and courses of study in use in progressive schools the Springfield science teachers have endeavored to formulate a three year course based on the idea so fittingly expressed by Edwin E. Slosson, late Director, Science Service, Washington, D. C.: "In the junior high school you have fresh brains which have not yet been partitioned off into idea-tight compartments for segregation of the several sciences. You have a chance to give your young men and women a vision of the promised land from a Pisgah peak before it has been divided up among the twelve jealous tribes."

A vision of the promised land not based merely upon theoretical ideas but rather a study and sympathetic understanding of the pupil's environment as gained from eighteen trips with Mr. and Mrs. Average Citizen of

Springfield, Mo., their children—John Henry and Mary Ann and the dog Wag.

THE AVERAGE CITIZENS.

Let us introduce to you Mr. and Mrs. Average Citizen, their children—John Henry and Mary Ann and incidentally the dog Wag, the group with whom you are to take eighteen trips during the next two years. John Henry and Mary Ann are just healthy, happy, peppy, normal children, while their father and mother differ in only one way from most of the people you meet in every day life—they know how to enjoy, to really see, to appreciate and to follow up the big simple things of life—that because they are in our midst at all times are often overlooked. They know that the woods are full of sounds—voices, songs and echoes, that the winter tramp across the hard packed snow fields presents multitudes of strange and mysterious surprises, and that even the modest dandelion has its story to tell. It has always been one of their goals in life to instill the same spirit of understanding, of sympathy and of appreciation in the minds of John Henry and Mary Ann that has made life mean so much to them—an intimate personal feeling for the wonders at their own doorstep. You know it has sometimes seemed to me that even Wag has absorbed some of this spirit for when he sits crouched under some tree looking at a treed squirrel, his head cocked knowingly on one side, he has a look in his eyes which seems to say—"I know."

WHAT THE TREES SAY.

God's out of doors
Was meant to play in;
Was meant to work in;
Day out and day in.
In Summer's sun
Or Winter's blowing
God's out of doors
Is worth knowing.

—Louise F. Brand.

So as we enter on this series of trips it is our wish for you boys and girls of the seventh grade that you too learn WHAT THE TREES SAY, that you may learn to appreciate and enjoy the wonders at your very doorstep.

General Statement of Plan.

1. The courses for the seventh and eighth grades represent eighteen trips to be taken in the vicinity of Springfield, Missouri.

2. As the outlined courses for the seventh and eighth grades proceed, Mr. Average Citizen of Springfield serves as a guide for his family, and attempts to point out to them as they are enjoying the eighteen trips around their home city:

a. The important part Science plays in modern living and in human welfare in our daily environment.

b. The enjoyment a boy or girl may derive from the gratification of that natural curiosity which is the primitive endowment of man, and which has borne him onward in his struggle for a worthwhile civilization.

c. That the scientific study of our own surroundings is a sane preparation for a sane State.

d. That all worth-while scientific problems connected with the civic and social aspects of the life of their community may be studied on trips enjoyed in the immediate vicinity of their own city.

3. The story of Mr. Average Citizen and his family is told in the preview preceding each Unit or Trip and is continuous throughout the courses for the seventh and eighth grades, the purpose being to add interest and background.

Each Unit or Trip is another chapter in the life of the Average Citizens.

Organization of Trips.*

1. The work of the seventh and eighth grades includes eighteen trips.

2. Each trip represents the spoke of a wheel, the nine spokes making up a wheel of which Springfield is the hub. On the rim of the wheel, and at the end of each spoke the exact point in the vicinity of Springfield to be visited is indicated.

3. The nine trips of the seventh grade place emphasis upon Nature Study in its relation to the pupil's environment, and upon the health of the individual.

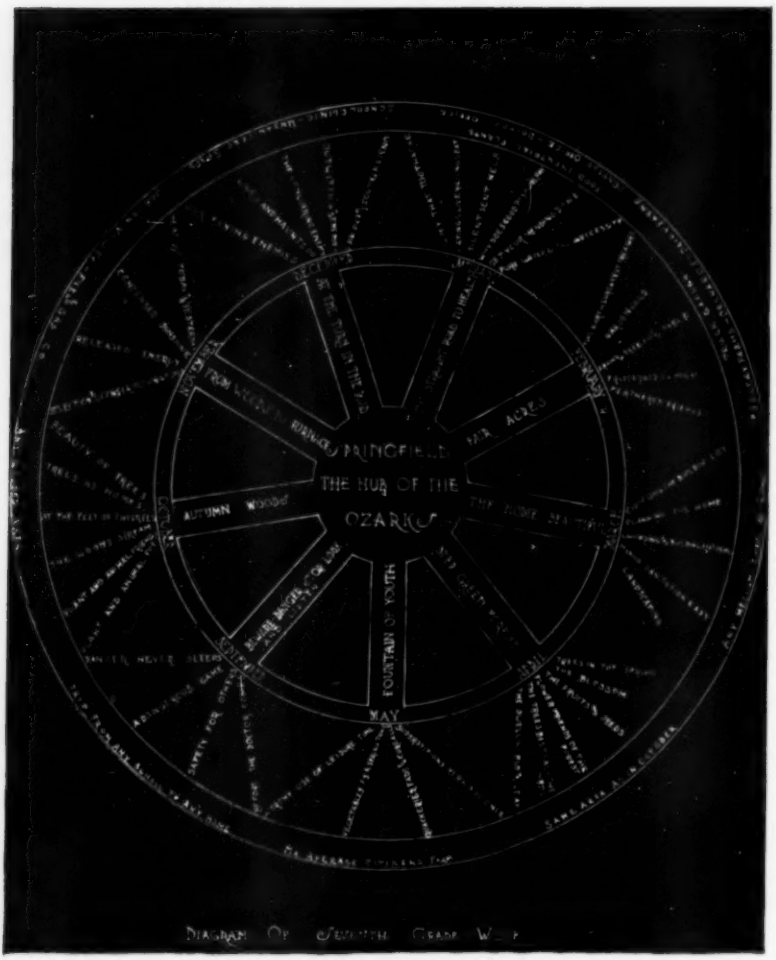
4. The nine trips of the eighth grade place emphasis

*The idea of the wheel and trips originated with six Senior High School teachers; namely—Hattie E. Reich, Chairman, Beulah Zilles, Jessie L. Elliott, J. Raymond Clouse, Hazel Seddon, and Lura McNish.

upon the physical laws as they affect the environment of the pupil.

5. Each spoke represents a unit of work and is continuous through approximately four school weeks. Effort has been made to organize the material so that the information acquired and the habits learned in the preceding units may be used in studying the next unit.

6. Each spoke or unit outlines work which is of special interest for pupils at the particular time of the year the work is offered.



Contents of Course—Seventh Grade

SEPTEMBER—Unit or Trip I
"BEWARE—DANGER—STOP, LOOK AND LISTEN"
A study of Fire Prevention and Safety First.

OCTOBER—Unit or Trip II
"AUTUMN WOODS"
Plant and animal life of the autumn woods.

NOVEMBER—Unit or Trip III
"FROM WOODS TO FURNACE"
An appreciation of man's dependence upon fire by an understanding of the development and use of fire as man's interest has increased.

DECEMBER—Unit or Trip IV
"AT THE TURN IN THE ROAD"
A study of a few of the basic principles underlying health.

JANUARY—Unit or Trip V
"THE STRAIGHT ROAD TO HEALTH"
Health habits and simple physical tests.

FEBRUARY—Unit or Trip VI
"FAIR ACRES"
The products of the farm.

MARCH—Unit or Trip VII
"THE HOME BEAUTIFUL"
The essentials of an ideal home.

APRIL—Unit or Trip VIII
"THE DEEP GREEN FOREST"
Plant and animal life of the woods in spring.

MAY—Unit or Trip IX
"THE FOUNTAIN OF YOUTH"
Scientific facts versus superstition.

Contents of the Eighth Grade Course of Study

UNIT OR TRIP I. BURIED TREASURES
A study of the rocks and minerals of this region.

UNIT OR TRIP II. LOOKING THROUGH A TELESCOPE
What you can see in the heavens any clear night.

UNIT OR TRIP III. MAN'S SERVANTS
A study of the machinery used by man today.

UNIT OR TRIP IV. OUR HOUSEHOLD SERVANTS
How we use electricity in the home.

UNIT OR TRIP V. LOOKING BACK OVER CENTURIES
Important inventions.

UNIT OR TRIP VI. TRAPPED ENERGY
The story of light and heat.

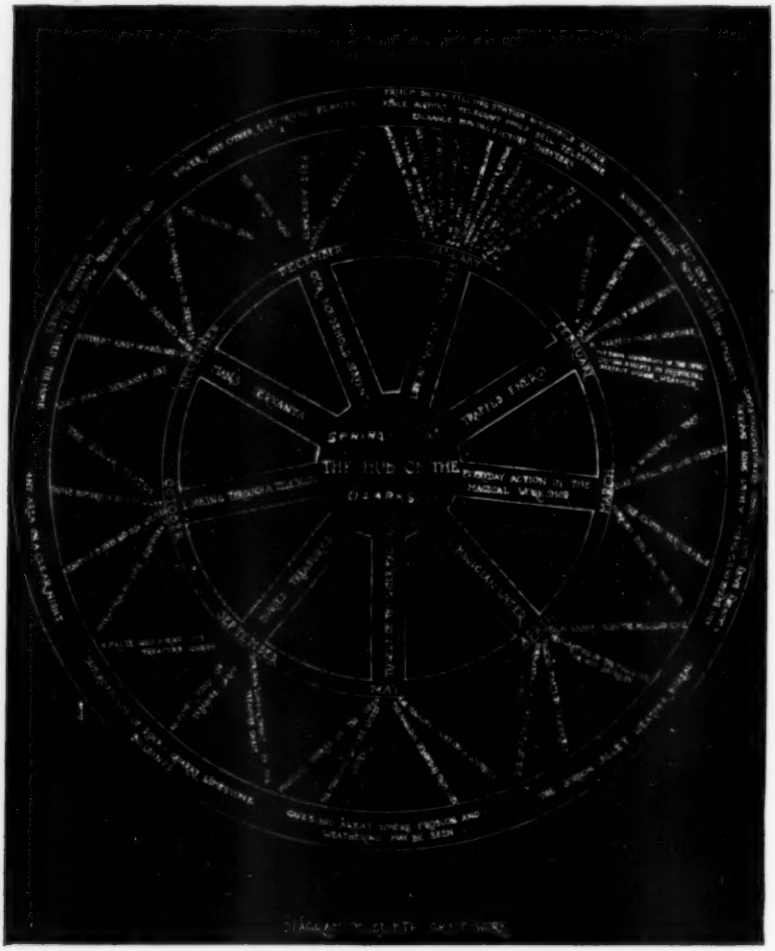
UNIT OR TRIP VII. EVERYDAY ACTION IN THE MAGICAL WORKSHOP
The chemical story of "Breakfast is Served."

UNIT OR TRIP VIII. THE MAGICIAN—WATER
The preparation of the magician for the journey, evaporation, condensation, etc.

UNIT OR TRIP IX. TRAVELS OF THE WATER MAGICIAN
The results of the journey of the water magician, weathering, etc.

Contents of the Ninth Grade Course of Study

UNIT I. OUR INVISIBLE OCEAN. FIVE WEEKS
A study of the atmosphere—occurrences, properties, composition, relation to sound, and the value of pure air in the promotion of healthy individuals.



UNIT II. OUR UNIVERSAL SOLVENT. FIVE WEEKS
A study of water, its sources, Springfield's Water System, methods of purification, uses.

UNIT III. RADIANT ENERGY. FIVE WEEKS
The place and value of heat and light in our daily life.

UNIT IV. EVERYDAY CHEMISTRY. FOUR WEEKS
The simple underlying principles of Chemistry as applied to our daily life.

UNIT V. OUR SILENT FRIEND. FOUR WEEKS.
The basic principles of electricity and magnetism.

UNIT VI. SCIENTISTS AND THEIR SCIENTIFIC INVENTIONS. THREE WEEKS
Some of the men who have contributed to the progress of the world.

UNIT VII and UNIT VIII. PLANT AND ANIMAL LIFE. TEN WEEKS
Plant and animal life with an appreciation of life processes.

BACKGROUND AND FOREGROUND OF GENERAL SCIENCE.

No. XII. WHAT THE WORLD IS LEARNING ABOUT FOOD.

By WM. T. SKILLING,

State Teachers' College, San Diego, Calif.

Instinct teaches a brood of young chicks what to do with a worm or a dish of scratch feed. Appetite is a very important guide to a boy or girl in the choice of food, and one that should be given all due consideration by parents and physicians. Without this natural guide as to what to eat and when we have had enough the digestions of even the best informed dietitians would suffer.

But after admitting that our natural desire for food is indispensable in the choice of diet we must remember that under the artificial conditions of civilization natural desires are often a poor guide to follow. Nature is not to be despised but it can often be improved upon.

One of the reasons why science is wiser sometimes than appetite in the choice of diet is that we are inclined to crave what we see on the table, and if this is a poorly selected combination of foods appetite is led astray. It does not have a fair chance to be a wise guide. If girls, especially, could be given as much insfruction in the choice and preparation of menus as they are in algebra and geometry, perhaps at the expense of the latter, they would become happier and more useful.

General science has provided a home for many valuable branches of knowledge: it may well furnish refuge for at least a brief course in dietetics. If defense of its position in the science class is needed it may easily be found in the fact that much that is fundamental in the subject is taken directly from chemistry and physics; for example the following.

Probably ten people use the word "calories" to one who understands what it means. Only a demonstration will make it clear to a class of children. If a liter of water is measured out into a beaker or a cooking utensil and after its temperature is taken with a centigrade thermometer it is heated until it is one degree warmer it has absorbed one calorie such as is referred to in books on dietetics. As we continue to heat the water it of course

absorbs a calorie for each rise of a degree, and the total amount of heat absorbed is found for any quantity of water by multiplying the number of liters (or the weight in kilograms,) by the rise in centigrade degrees.

But what has this to do with food values? When Lavoisier discovered oxygen he thought that oxidation must take place in the lungs. That seemed to be as far as the breath went. But later it was found that the lungs were no warmer than any other organ, and that they were only the vestibule from which oxygen was distributed to all parts of the body. Children should learn that respiration is a far greater process than merely drawing air into the lungs and then expelling it. Each of the millions of cells to which oxygen is brought by the blood absorbs some of it and gives in return to the blood stream the bit of carbon dioxide and water resulting from the process of oxidation. Food can scarcely be discussed without a discussion of respiration.

Attention of pupils should be directed to the cells of the body. Each tiny muscle cell may be compared with the engine under the hood of an automobile. Air (oxygen) enters, from the carburetor in one case, from the lungs in the other. Simultaneously a combustible (oxidizable) material enters to unite with the oxygen. In case of the engine it comes from the gasoline tank. In case of the muscle cell from the digestive tract.

Both heat and energy are the result in each instance. Combustion in the engine keeps it hot, and oxidation in a cell, and a million more, maintain a body temperature of $98\frac{2}{5}°$ F despite continual loss by radiation, etc. The engine by virtue of the chemical change within it can do work. The cell by a different and more obscure process, is given power to contract.

Considerable attention may well be given to the similarity of the processes of burning and oxidation. If food is burned it will produce the same amount of heat as if it is oxidized in the cells of the body. Just as some grades of coal will give more heat than others, and as gasoline will give about fifty per cent more heat than the best coal so some foods give more heat (or energy) than others. For example oil or any fat gives about $2\frac{1}{4}$ times as much

heat as either sugar, starch, or protein, whether they are burned or digested.

To more explicitly connect the action of food in the body with that of fuel in the engine we may compare the number of calories of heat which can be developed by the food of a man with the number produced by burning gasoline in an engine. Suppose an automobile during a long day's run uses up 15 gallons of gasoline. This while being burned generates about 500,000 calories of heat. It is this heat, or a part of it, that gives the auto energy to run. The food that a man at moderate work will need is able to develop about 3,000 calories in the body, and it is this that gives the man energy to work.

General science lessons cannot supply the minimum of science which every one should know without treating the subject of the chemistry of food. To do this for pupils who have not studied chemistry demands simplicity. But it should not be difficult to make plain the classification of food requirements into carbohydrates, fats, proteins, and mineral matter. Though these are often mixed in ordinary articles of diet they exist in pure form in enough cases for illustration. For example, sugar, butter, lean meat, and salt may serve as representatives.

Children should learn the peculiar function of protein which alone can build muscle tissue. While learning the importance of sufficient meat, milk, eggs, beans or other foods rich in protein they should be cautioned against an excess of such things, which may put a severe strain upon the organs of elimination. Dietitians usually recommend that only sufficient nitrogenous food (protein) be used to supply growth and repair to the protein cells of the body. It *will* furnish heat and energy but carbohydrates and fats are considered safer to use for all heat and energy requirements above the amount supplied by what protein food must be taken to furnish nitrogen, sulphur, phosphorus, etc.

Climate, occupation, age, etc., determine what are the best proportions of fats, carbohydrates and proteins to use in the diet, but a *one, five, one* ratio is considered a good combination. That is one part fats, five parts carbohydrates, and one part proteins. Or, putting this in terms

of total quantity for a man at work it would be as follows:

Fats 100 grams (900 calories)

Carbohydrates 500 grams (2,000 calories)

Proteins 100 grams (400 calories)

Total 700 grams (3,300 calories)

Specialists are agreed that milk is an excellent protein food for growing boys and girls. If they take a quart of whole milk a day they will get more than an ounce of pure protein of the highest quality for promoting growth.

Not only are fats, carbohydrates and proteins needed in suitable proportions and in sufficient amounts to produce the requisite number of calories of energy in the body but they should be so chosen as to provide the mineral matter necessary. Some foods are rich in certain minerals, some poor.

There are about a dozen different mineral substances in the body requiring more or less constant additions to keep up the supply. The mineral elements most likely to be lacking in the diet are calcium, phosphorus, and iron, and in some inland sections of the country iodine. Food that contains sufficient of these elements is likely also to contain enough of the other minerals needed.

Sufficient calcium is supremely important in the diet of growing children. Feeding experiments with rats have shown the stunting effect of calcium deficiency. Not only are bones composed of calcium phosphate but lime is needed throughout the body for the proper functioning of muscles and nerves.

Many foods contain lime but milk, which is rich in it, seems to furnish it in a form best suited to the growth requirements of children. There is more calcium in milk than there is in a saturated solution of lime water. A quart of milk a day ensures sufficient calcium.

The importance of iron in the blood has long been known, and modern experiments emphasize the need and point to some of the best sources of iron in the diet. Iron's chief function is to help form the compound hemoglobin, which gives the red color to the blood. Though in the human body there is at any one time only one tenth of an ounce of iron, an amount equal to the weight of a copper cent,

yet it is distributed among 25,000,000,000,000 red corpuscles, each one having a share.

It is the hemoglobin that absorbs oxygen and carries it to all parts of the body. So important a function shows how indispensable iron must be. Anemia is a disease in which hemoglobin is deficient in the blood. If anemic a child should use foods containing iron, such as egg yolk, green vegetables, and especially *liver*.

Another phase of our subject demanding some attention is that of vitamins. Even in this country where diet is as a rule so varied and ample deficiency of necessary vitamins sometimes causes trouble. Besides, the very wide spread interest and partial knowledge of the subject demands that everyone know something about this mysterious substance of food. We want our bright young high school pupils to be better informed than the waiter who explained foreign particles seen floating in the soup as being "some of those vitamins that everybody is talking about."

The topic is worthy of one or two class periods. Attacked from the historic point of view we may go back at least to 1898 when the Dutch chemist Eijkman, working in Java, discovered that Beri-Beri, a disease of the nervous system common in the Orient among people living largely on polished rice, could be prevented or cured by a small quantity of some substance extracted from the rice polishings. His experiments were performed with chickens.

Later E. V. McCollum, at Baltimore discovered that butter and egg yolks contain a substance which prevents a certain kind of eye trouble common among Orientals who live on a restricted diet. It also is necessary for the proper growth of children. He named this substance Vitamin A, and later the one discovered in rice polishings was called Vitamin B.

In 1912 it was found that the long recognized ability of citrus fruits to prevent scurvy is due to another of these mysterious substances to which was then applied the name Vitamin C.

Because Vitamin D is found in some of the same substances that abound in vitamin A, namely cod liver oil and egg yolks, it long remained undiscovered, and its effects

were wrongly attributed to A. It is the antidote for rickets, a disease of the bones of children.

Strange to say though Nature has not been very lavish with this vitamin it can be developed in many foods by letting sunlight or artificial ultra violet light shine upon them. Stranger still the human body seems to develop its own vitamin D if given sufficient sunshine. Hence daily sunbaths for infants, who are most subject to rickets. This is a disease which has long been known to be most prevalent in the winter, when we get less sunshine.

One other vitamin called E has been detected in the process of experimentation with white rats, which are the animals usually studied in such research. This vitamin has to do with reproduction. In its absence young rats were not produced.

Vitamins are not food in the sense that they produce calories of heat or energy in the body, but they must be present in small amounts to make our food fulfill its purpose.

Their chemical composition and other properties have not been discovered but their effects are known, and we know also what foods supply them.

If the science course can give pupils an intelligent interest in the proper use of food it can serve no more important purpose. Information precedes interest. But after some such facts as the above are discovered the class should be ready to consider practical health suggestions such as the foolishness of fads in diet, the danger in under nourishment for the sake of form, the necessity of fruit and vegetables and coarse foods to prevent sluggishness of the intestines.

An exercise which pupils enjoy and which helps to call their attention to the subject of the choice of foods is to make wall charts showing ideal or faulty menus. Colored pictures may be found in abundance in magazines to illustrate these charts. Such subjects as a suitable breakfast, a meal supplying iron, a combination rich in proteins or in fats, or one containing various vitamins, may be suggested for illustration upon these picture charts.

THE ELEMENTS OF PLANE GEOMETRY IN HIGH SCHOOL PHYSICS.*

BY HOBSON M. ZERBE,

J. M. Coughlin High School, Wilkes-Barre, Pa.

The purpose of this study was to determine the elements of plane geometry which the high school student should know for his work in physics. This problem was attacked from several angles. The first was to determine those theorems which the student should know to understand the discussions presented in the text-book. The second was to determine those theorems and constructions which the student should know to perform the laboratory exercises satisfactorily. The third was to determine the geometric terminology used in the physics text-book.

Ten different text-books were examined to determine the theorems which the student should know to understand the discussions presented in the text-book. The frequencies of the references to and the uses of the various theorems and principles of plane geometry were tabulated. In some cases the text-books made direct mention of a specific theorem. In other cases the reader had to know certain theorems or principles to understand the discussion. In making the frequency study, only those theorems and principles which were mentioned directly or those which the reader had to know in order to understand the given discussion were used. When the same theorem or concept was used more than once in the same discussion its frequency was counted as one.

The text-books examined for the frequency study were: Black and Davis, Practical Physics; Carhart and Chute, Elementary Principles of Physics; Dull, Essentials of Modern Physics; Fuller, Brownlee and Baker, Elementary Principles of Physics; Gorton, High School Course in Physics; Henderson, Physics in Everyday Life; Hoadley, Essentials of Physics; Millikan and Gale—Pyle, Practical Physics; Sears, Physics for Secondary Schools; Tower, Turtin, Smith and Cope, Elements of Physics.

To determine those theorems and constructions which the student should know to perform the laboratory exercises, six laboratory manuals were examined. An analyti-

*This article reports the findings of an investigation for a Master's thesis at the Pennsylvania State College.

cal study was also made of the theorems and constructions used in the development of the more commonly used physical laws and formulas. Among the topics analyzed in this connection were the inclined plane, formation of images, composition and resolution of forces, wheel and axle, hydraulic press and the lever.

In this analysis the fundamental laws of ratio and proportion and the uses of the mensuration formulas were not considered. Ratio and proportion was not considered because the fundamentals of these principles lie in the domain of algebra. It is essential that the student should know the mensuration formulas of the triangle, parallelogram, circle, etc., and their uses. But in almost every case the student is familiar with these formulas and their applications before the study of physics is begun. The development of these mensuration formulas lies in the domain of plane geometry, but the teacher of high school physics is concerned about the student's ability to use the formulas and not about the student's ability to derive them.

In this frequency study and analysis, twenty-five theorems and ten constructions were found which the high school student should know for the work in physics. These theorems and constructions are listed below.

SUMMARY OF THEOREMS.

Note: The theorems marked with F are those which occurred in the frequency study and the number following the F indicates the frequency of occurrence in the ten different text-books. The theorems marked with A are those which occurred in the analytical study.

1—Two triangles are similar if two angles of one are equal respectively to two angles of the other. F-10;A

2—Two right triangles are similar if an acute angle of the one is equal to an acute angle of the other. F-13;A

3—If a line parallel to one side of a triangle intersects the other two sides, a triangle is formed which is similar to the given triangle. F-2.

4—In any right triangle the perpendicular from the vertex of the right angle to the hypotenuse divides the triangle into two triangles, each of which is similar to the given triangle. F-3.

5—The bisector of an angle of a triangle divides the opposite side into two parts which are proportional to the adjacent sides. F-2;A

6—The corresponding sides of similar triangles are proportional. F-28;A

7—If two triangles are similar, the altitudes from the corresponding vertices are in the same ratio as the corresponding sides. F-7;A

8—If two parallel lines are cut by a transversal the alternate-interior angles are equal. F-10;A.

9—If two straight lines intersect, the vertical angles are equal. F-16;A.

10—If two angles have their sides respectively perpendicular, they are equal. F-5;A

11—If two angles have their sides respectively parallel, they are equal. F-3.

12—Complements of equal angles are equal. F-3.

13—Two right triangles are congruent if a side and an acute angle of the one are equal respectively to a side and an acute of the other. F-4.

14—In a right triangle the square on the hypotenuse is equal to the sum of the squares on the other two sides. F-20;A

15—If two chords intersect within a circle, the product of the segments of the one is equal respectively to the product of the segments of the other. F-3.

16—An angle inscribed in a semi-circle is a right angle. F-3.

17—In a 30-60 degree right triangle, the side opposite the 30 degree angle is equal to one-half the hypotenuse. F-1; A.

18—The circumferences of two circles are in the same ratio as the diameters or as the radii. F-12;A.

19—The areas of two circles are in the same ratio as the squares of the diameters or as the squares of the radii. F-17;A.

20—If two sides of a quadrilateral are both equal and parallel the figure is a parallelogram. A.

21—The opposite sides of a parallelogram are equal. A.

22—The opposite angles of a parallelogram are equal and the consecutive angles are supplementary. A.

23—If the opposite sides of a quadrilateral are equal, the figure is a parallelogram. A.

24—The diagonal of a parallelogram divides it into two congruent triangles. A.

25—Corresponding parts of congruent figures are equal. F-4.

Concepts which occurred in the frequency study which are not mentioned in the above summary are as follows:

A—Parallelograms; used to illustrate the principle of composition and resolution of forces. This concept had a frequency of 91. Theorems 20, 21, 22, 23 and 24, for which no frequency was given may be considered under this classification.

B—Concept of sine had a frequency of 7.

C—Concept of cosine had a frequency of 1.

SUMMARY OF CONSTRUCTIONS.

1—From a given point on a given straight line, required to erect a perpendicular to the line.

2—From a given point without a given straight line, required to erect a perpendicular on the line.

3—Required to draw a line parallel to a given straight line.

4—Required to bisect a given angle.

5—Required to draw a line to scale.

6—Required to construct an angle equal to a given angle, either with the use of a protractor or the ruler and compasses.

7—Required to construct a parallelogram, having given the two sides and the included angle.

8—Required to construct a parallelogram, having given the diagonal a side and the angle included between the diagonal and the side.

9—Required to construct a parallelogram, having given the diagonal and the angles between the diagonal and the two adjacent sides.

10—Required to construct a parallelogram, having given the diagonal and the two adjacent sides.

A NATURE TRAIL AT BERNARDS HIGH SCHOOL.

By FRANKLIN R. MYERS,

Bernards High School, Bernardsville, N. J.

We could trace the call to study nature out-of-doors to several of our early educational leaders, but no one in our country has taught us more potently than Agassiz the value of this method. His "Study Nature, not books," while we cannot adhere to it to the letter, we can when the opportunity affords, vitalize our biology with real contact with living things.

Nowhere else can this be done so well I think, as in the construction of a Nature Trail as a biology class project.

What is a Nature Trail? It has been called a path through the woods along which the trees, shrubs, small plants, and other natural objects of interest have been labeled. The model trail built by Dr. Frank Lutz (1926)[1] of the American Museum of Natural History at Bear Mountain, near Tuxedo, New York has as the first sign greeting the visitor: "A friend somewhat versed in natural history is taking a walk with you, and is explaining interesting things." The "friend" turns out to be the label.

The Nature Trail being built at Bernards High School is aiming to tell the story of living things in a clear, interesting, and not too technical manner.

It is of great benefit to our school that in the gift of land for the present buildings is a nearby tract containing 5.8 acres of fine woodland crossed by a small stream. Large oaks, beeches, cherries, and birches together with many native plants make it a spot wonderfully adapted to a Nature Trail project. With this gift of nature at the outset, we have proceeded to add various features to increase its use and attractiveness. It is the early work leading up to the present of which I wish to tell.

Starting when the woods were damp and mucky in places, stakes were driven twenty feet apart forming a tentative path. The direction taken was such that the peculiar shape of the tract was utilized to the utmost. The entrance was clearly set off from the return path, and

[1] LUTZ, DR. FRANK E., Nature Trails. An Experiment in Outdoor Education. 1926. Miscellaneous Publications No. 21 of The American Museum of Natural History.

nowhere were two trail sections brought closely together. The way led across the stream which it traversed at two points over two log bridges constructed by the manual arts classes.

Having decided on the layout of the path, the matter of transforming this into a true Nature Trail came next to our attention. Over one hundred plants and other objects were labeled with a tag bearing the correct name together with additional facts concerning each. For the purpose linen shipping tags of three sizes were used. (2½ in. x 4½ in., 2½ in. x 5½ in., and 3 in. x 6 in.). Waterproof India ink proved the best for writing the labels. These withstood the weather conditions and so were suitable for more than one season. They were tied to the plant by ordinary green cord or tacked with copper tacks to stakes. Tags were spaced from twenty to forty feet apart so that the feeling of progression along the path would not be lost.

The biology classes prepared and wrote the labels. This was done by assigning to each member one or sometimes two plants for special study and reading. The habits of the plant were of course seldom suitable material for a label because the living plant was a witness to these points; rather some facts about its use, value, natural history or a legend concerning it made best material. Our trail was to avoid giving the effect of technicality and a studied teaching attitude.

After gathering information from several sources, each pupil was instructed to write the label for his special plant in exactly the form he wished it to appear on the linen tag. The labels were not to be too long—seldom over 30 words—free of technical terms, interesting and un-bookish. After several trials and corrections, the tags were printed and placed on the Nature Trail at the proper place. The following are three examples of what we felt for our first effort were satisfactory labels:

POISON IVY.

May be confused with Virginia Creeper but remember Poison Ivy has three leaflets and Virginia Creeper five.

COLUMBINE.

This plant received 197 votes in the National Flower poll. It is one of the few flowers visited by the Ruby-throated Hummingbird for nectar.

EVER USE POND'S EXTRACT?
In Indian language this Witch Hazel was called "spotted stick." From its bark and twigs the extract is made.

Because the woods had been depleted of herbaceous plants in previous years the pupils were asked to bring plants to place along the trail. Nearly two hundred of various species were brought.

Many things remained to be done, such as building up the path to prevent wet feet, constructing bridges, walks, and fireplaces, clearing the stream, and planting a fernery around a small spring. In all this the pupils offered valuable ideas which were or will be carried out.

Our nature trail has seen but one season; that of its beginning in 1929. This spring we enter upon our project with plans for a rustic cedar entrance, the addition of many more plants, and the division of the path into three sections; namely, Section B—General ideas and facts about plants and animals; Section H—devoted especially to plants; Section S—devoted to animals.

The first year no animals were kept on the trail. Many species are met with in our woods, and as the lesson of conservation needs especial emphasis in our district, a frog house and a turtle and snake pen will be added.

Lastly to weld the project into one embracing the township and community we are conducting a Nature Hunt or Contest for which prizes will be offered to individuals recognizing the greatest number of plants and answering the greatest number of questions correctly on the Trail.

For convenience, those competing will be placed in the following groups:

Division 1. High school pupils who have studied biology.
Division 2. High school pupils who have not studied biology.
Division 3. Pupils of public or private elementary schools in the District.
Division 4. Citizens of the District who are not attending school.

A nature trail is never complete; more and more ways of improvement appear each day as we work upon it. So far it has shown itself to be a real awakener of interest in the out-of-doors. What was begun as a biology class project, has become a school project. We look forward to a continuance of this interest. In part, then, the admonishment to "Study Nature, not books," may be fulfilled.

GENERAL SCIENCE IN THE JUNIOR HIGH SCHOOLS OF LOS ANGELES.

By W. L. NOURSE,

John Burroughs Junior High School, Los Angeles, Calif.

In the Junior High Schools of Los Angeles two courses in General Science are being given. In the lower eighth grade is offered a twenty weeks' required course. Since this course is the only required one, and since many pupils leave school to go to work when they leave the Junior High School, the course is very inclusive. It is divided into three parts—plant life, animal life, and physical science. In twenty weeks only the high spots can be touched, but it seemed better to touch lightly than to ignore any of these very important branches of science.

The objectives of this course as stated in the outline are to teach the scientific method and attitude, to create an interest in the special sciences given in Senior High School and the university, to effect an understanding of the practical value of science and the ability to practice it in everyday life, to build up a scientific vocabulary, to instill an interest in scientific literature, to teach future citizens to study civic problems from a scientific standpoint, and to develop a desire to lead a clean, hygienic life.

Since the content of the course was changed at intervals, no textbook has been used. Wide use was made of libraries, newspapers, periodicals, and other supplementary reading. Pupil activity was constantly urged. In the last year it became evident that the course was sufficiently stabilized to warrant the use of a textbook. In order to select one as scientifically as possible, the following method was followed:

(1) Each science teacher was asked to write his ideas of the prime requisites of a good science text.

(2) The replies were tabulated and condensed to 14 which were then weighted.

(3) Each teacher was asked to name two or three texts which he considered worthy of evaluation.

(4) The replies were tabulated, and the six texts having the largest number of votes were selected for evaluation.

(5) Committees examined these texts in the light of

each of the 14 requisites, and made reports in which the texts were designated by numbers. The reports of these committees were distributed to all teachers of lower eighth grade science. These teachers were asked to rank the texts in each of the 14 requisites, basing their judgment solely on the reports of the committees.

(6) The votes in each requisite were tabulated, and the texts were ranked according to the combined judgment of the teachers. The rank of the text multiplied by the weight of the requisite gave the final result for that requisite. The final results for all requisites were added, and the book holding the highest rank was recommended for adoption. The teachers heartily approved of this method of evaluation, and were almost unanimously satisfied with the result.

The fourteen requisites for a good text which were used are given below: (The weight of each item is given in parenthesis.)

1. The book must be up-to-date. (8)
2. It must contain historical background, tying the present to the past. (3)
3. It should contain a large amount of material required in the course of study, and a wide range of other appropriate material. (29)
4. It must be suited to the environment (the daily life of the pupil) (12)
5. It must have clear print, good paper, and binding. (3)
6. It must contain suggestions for applying knowledge. (2)
7. New topics should be emphasized by bold face type, the book should have a complete index, references to books, and a glossary. (9)
8. There should be many illustrations, labeled, and aptly placed. (7)
9. There should be clear definitions, and in foot notes the pronunciation of difficult words. (3)
10. Simple experiments should be given throughout the text. Suggestions for home experiments, collections, and projects should be numerous. (13)
11. There should be adequate explanation of demonstration experiments. (3)
12. The relationship between plants and animals should be clearly shown. (3)
13. Thought questions should be numerous. (1)
14. The text should be suited to various mental ages. (4)

The other course in General Science given in the Junior High Schools of Los Angeles is ninth grade science—a forty weeks' course. It was designed to meet the usual purposes of a science course. These are too well known to warrant enumeration. It is an elective, the alternative being World History.

In our system foreign languages are introduced as electives in the upper eighth grade. For the pupils who have not desired to take any foreign language, or who should not take one, it has been difficult to provide another subject. To meet this difficulty it has recently been decided to provide a course in upper eighth grade science with the proviso that it shall not encroach on the lower eighth grade or the ninth grade science. A committee is now at work outlining such a course. While no decision has yet been made, it is likely that the course might properly be entitled "Problems in Science." It may include a study of water supply and sewage disposal problems, new inventions and discoveries, and the most recent developments in aviation, radio, and television. Since neither the eighth nor the ninth grade science course emphasizes particularly the civic aspects of science, and since those who elect upper eighth grade science will be to a considerable extent those who will soonest leave school to go to work, it is probable that the civic importance of science may be stressed in that course.

ERRORS MADE BY GENERAL SCIENCE PUPILS.

By WM. W. GROOM,

Science Instructor, Fowlerville High School, Fowlerville, Mich.

A real teacher does not merely mark papers as correct or incorrect, but he goes further and tries to diagnose the cause for the error and thus give corrective treatment. In studying the errors made by pupils of general science certain general causes for these errors have been revealed. The principal types of errors, eight in number, are as follows: (1) misunderstanding the text, (2) memorizing the text instead of reasoning, (3) not using or interpreting the diagrams, illustrations, etc., (4) not forming a thought picture from the printed words, (5) not distinguishing betwen major and minor points, (6) forming hasty conclusions, (7) not identifying the type of work needed to secure answers to the questions, and (8) failing to see the relation between experiments and subject matter. It is, therefore, the teacher's job to give

corrective treatment in order to remedy these causes of errors, so I shall endeavor to point out the reasons for these errors and suggested remedying helps.

Misunderstanding the text is generally due to either carelessness in reading or in attempting the test before having understood the text. The errors are incomplete, incorrect or off-the-question answers and can be corrected often by having the pupil write or state the problem in his own words. In case the pupil continues to misunderstand, he should be shown how it helps to state it in his own words.

It is very easy to tell when pupils are memorizing the text instead of rationalizing it. A thought question put to them is like asking them a question in Philosophy or some subject unknown to them. If they have been memorizing, they are completely lost. This memorizing may be stopped easily by repeatedly giving short written reviews which call for reflective thinking.

Pupils who think that the diagrams, pictures, etc. shown in their texts are merely for entertainment are at a loss when asked to interpret them as he does not know how to study them. It is very important that the teacher assist the pupils in the interpretation of these cross-section drawings, graphs, tables, etc. Practice can be given in making cross-sectional drawings from the actual apparatus, or making graphs from tables and tables from graphs.

Many pupils can easily tell how an apparatus operates but in reality they do not have the slightest understanding of its operation. For instance, let us take the case of the gasoline engine. The pupils look at the diagram in the book and learn the steps of operation without understanding them. If called upon to make a drawing of the engine with the pistons and valves in another position, they could not do it. This calls for a mental picture combined with solid thinking and reasoning. It is a good practice to call upon them to explain the working of the apparatus beginning at another point and giving reasons for every statement. It may also help to have them make a drawing of the apparatus in another position than given in the text.

The inability to find the main thought and to place its minor thoughts under it is very common. There are two main causes for this inability, namely, a lack of knowledge concerning chapter or paragraph structure and a lack of definite purpose in his selection of facts. This inability may be easily found by having the class outline the lesson. Practice in outlining with constant supervision by the teacher is necessary to correct this handicap.

Forming hasty conclusions is probably the greatest fault of them all and is merely the habit of not stopping to think what the question means. This habit of taking the first suggestion which comes to the mind must be broken. Practice must be given in recalling or forming as many possible conclusions or solutions as possible and then, after testing each one of the solutions, pick out the right one, or the one which appears to be most nearly right. Matching and multiple choice questions are a good practice exercise for making them think before acting.

Many pupils, upon failing to find the answer to a question in the text, give up immediately. They also sometimes write everything they can concerning the topic, which covers too broad a territory and balances the correct and incorrect answers. The pupils must here be shown that the trouble is in their procedure. In correcting it have the pupil restate the problem or question in his own words, tell him to ask himself what he has to know in order to answer the exercise and how to go about its solution. In case he then has trouble, the teacher should show him the method to be used in that case and then give him practice in problems of a similar nature.

In experimental problems the pupils do not always connect them up with the text, thus their answers are faulty due to the fact that they fail to see the contribution of the experiment. The teacher must point out this fact to the student and then on another question which requires writing out the principles presented by the experiment, he will see the value of the method. Writing reports of each experiment is a helpful practice.

This supervision of study in the beginning courses of science is very important. The method of study is one of the important ends in view.

THE ADLER PLANETARIUM.

By W. W. Gorsline,

Crane Junior College, Chicago, Ill.

A great event took place on the afternoon of May 10 on Chicago's lake front in the dedication of the Adler Planetarium. This building is situated on the north end of the new island just east of the Shedd Aquarium. Mr. Max Adler presented this unique structure, costing one million dollars, to the South Park Commissioners for use of the citizens of Chicago and America. In presenting this gift Mr. Adler called it "a school room under the vault of heaven." Mr. Phillip S. Graver, Vice President of the South Park Commissioners, accepted the gift and said that every wish of the donor would be carried out and that this structure would be an everlasting monument to this noble minded gentleman.

The planetarium is the only one of its kind in America but there are twelve in Germany. The Zeiss foundation at Jena, Germany, designed the mammoth projector with its some two hundred lenses which is in the center of the main Auditorium. As one enters the front door he is confronted with a beautiful silver plaque showing the eight planets with their symbols grouped around the outside of the following inscription done on marble: "To further the progress of science; to give an understanding of the majesty of the heavens; to emphasize that under the celestial firmament there is order, independence and unity." The corridors surrounding the main auditorium are devoted to an astronomical and mathematical museum of ancient and modern instruments used in the study of these subjects. Cases are filled with sextants, astrolabes, quadrants, hour glasses and many of the old telescopes used by astronomers as far back as the sixteenth century. Numerous illuminated transparencies of celestial objects such as the new planet, moon, sun, etc., are placed in the walls with the proper explanations under them. Dr. Phillip Fox, the director, who traveled abroad and collected this wonderful museum is making an effort to enlist every one who may have in his possession some astronomical relic of the past to place it there in the museum.

The main auditorium is circular with a vaulted ceiling to represent the sky and an horizon showing the sky line of Chicago with its loop on the west, Navy Pier on the north and the lake with its cribs on the east. These buildings are all in black against the white background of the dome. In the center is located the large Zeiss projector with its some 200 lenses and resembles a huge dumb-bell. It is supported by a large frame work mounted on a track.

When the demonstration started the lights were low and one is given the impression of the time just before dawn. Mr. Fox, the director and demonstrator, occupied a booth at the north side and by a series of buttons and levers operated the projector. He had a spot light which could project an illuminated arrow at any place on the dome. After a few minutes of introduction by the lecturer concerning the aims and purposes of the planetarium in order to accustom the audience to the darkness, the sun comes up over the lake accompanied by the nearer planets Mercury, Venus and Jupiter in their respective positions for May 10. The sun was dimmed so these planets could be seen. These mounted higher and higher in the sky until the sun was on the meridian when, like Joshua of old, Dr. Fox commanded it to stand still when all the circles representing the meridian, ecliptic, equator, etc., were projected on the dome and could be clearly seen. Here in a few seconds we could read the declination, right ascension, altitude, etc.—terms which are difficult to get from diagrams in books but so easily portrayed that a child could understand them. Soon the sun was on its journey again and as it set behind the loop the moon came up out of the east. When it reached its highest point it was put out and a photograph taken by a large telescope showing the large crater, Copernicus, was thrown in its place. A further photograph taken by the 40-inch Yerkes telescope giving greater detail of this wonderful crater was also presented. The same thing was done with the planet Mars with its snow cap and equatorial markings. Soon the crowd gasped in wonder when 5700 stars including the milky way filled the dome. Such a spectacle is never seen in Chicago as the atmosphere

is so full of smoke the milky way never appears. As the crowd watched, the whole starry universe traversed the sky from east to west and among the stars we could see the planets moving about. Next the moon was speeded up in its motion and we could see it actually moving eastward among the stars making the entire trip in a month. By speeding up the projector the actual motion as well as the apparent motion of all the planets was easily displayed.

The projector can be shifted so that the appearance of the sky at the north pole of the earth as well as the equator is clearly shown. Furthermore the appearance of the sky 4000 years ago as the ancients viewed it as well as the sky 4000 years hence can be shown with great ease. As a teacher of astronomy for many years, I have found difficulty in explaining by use of diagrams, pictures, etc., many of the things which are made easily understandable even to the general public in a few minutes. Millions of dollars are spent in educating the youth of our day in the knowledge of affairs on the earth with its sciences, geography, government, etc., and now Mr. Adler has increased the educational opportunity by a noble act which gives to the public this great institution for extending the vision beyond the limits of this planet to the wonders of the mighty universe around us. This gift is not for Chicago alone but for all America and for our guests from distant lands.

MODELS FOR CHEMISTRY TEACHING.

By D. C. BARRUS

Science Department, Mount Hermon School, Mount Hermon, Mass.

A convenient and inexpensive set with which to build models of formulas of compounds is the common set of toys known as, "Tinker Toys." These may be bought at almost any toy store. The set as usually purchased does not contain enough spools and rods to make many models at any one time so that an extra supply ordered from the manufacturer will be found helpful.

As the spools will be used to represent different atoms, it is well to color some of them with different dyes. Three or four may be colored black, another group green and still

others red, blue and purple. Most of them, however, should not be dyed.

Models of Formulas.

Models of molecules are assembled as in figures 1 and 2. The spools represent the atoms while the rods indicate the valence. Figure 1 shows a molecule of calcium hydroxide.

Fig. 1. A model of the molecule of calcium hydroxide.

The spools representing calcium and hydrogen should be colored, the calcium being of a different shade from the two hydrogen spools. It is advisable to represent the oxygen atoms by the white spools. The two rods on each of the calcium and oxygen indicate a valence of two, while each of the hydrogen has but one indicating its valence.

The toys are so constructed that only one straight rod can connect two spools. In figure 2, a model of the sulphuric acid molecule, the sulphur atom has a valence of six and has six rods to correspond. In the figure it will

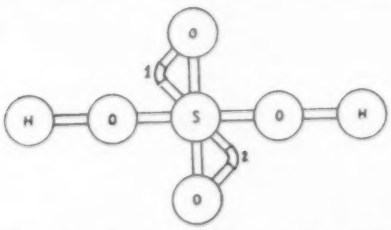


Fig. 2. A model of a molecule of sulphuric acid. 1, 2. Rubber tubing connecting short rods.

be observed that each of two of the oxygen spools is linked to the sulphur by two rods, one of which is L-shaped. This consists of two short rods joined by rubber tubing. In this way the valences of all the atoms in a molecule, no matter how complicated, can be shown.

Models and Chemical Changes.

Reactions between substances can be illustrated by these models. Thus, when calcium hydroxide reacts with sulphuric acid the calcium spool can be made to take the place of the two hydrogen spools by using rods of the proper

length and inserting them in different holes as is required. This gives a model of the molecule of calcium sulphate. The two hydrogen spools will take the place of the calcium and each will be linked up with an OH radical and two molecules of water are formed.

One disadvantage which is found in the use of these models is the fact that they can be represented in only one plane. However, after several years of use the writer has found that the quickness and the clearness with which students comprehend the ideas of valence, molecules and types of chemical changes by the use of models considerably outweigh the disadvantage.

PROBLEM DEPARTMENT.

CONDUCTED BY C. N. MILLS,
Illinois State Normal University.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor, should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to C. N. Mills, Illinois State Normal University, Normal, Ill.

PROBLEMS FOR SOLUTION.

1027. *Proposed by Richard Corsan, Indianapolis, Ind.*

A regular polygon just tumbles down an inclined plane whose inclination is 10 degrees. How many sides has the polygon?

1028. *Proposed by Helen Beatty, Denver, Colorado.*

Show that the area of a zone of a sphere of radius R illuminated by a lamp placed at the distance d from the surface is

$$\frac{2\ \text{pi}\ R^2 d}{R+d}$$

1029. *Proposed by Norman Anning, University of Michigan.*

In the regular pentagon ABCDE is inscribed the regular pentagram ACEBD. Show that, if we count twice the area which is surrounded twice, the area of the pentagram divides the area of the pentagon in golden section, i. e. in the ratio $(\sqrt{5}-1) : 2$.

1030. *Proposed by the Editor.*

Prove: The diameter of a circle inscribed in a quadrant of a second circle is equal to the side of the regular octagon circumscribed about the second circle.

1031. *Proposed by E. de la Garza, Brownsville, Texas.*

Find the sum of n terms of the series

$$1+8+19+34+53+76+\text{—}.$$

1032. *Proposed by Ruth Laken, Detroit, Michigan.*

Prove: The right cone, whose slant height is to the radius of base as 3:1, has the maximum volume within a given surface.

CHIEF BUGHUNTER.

BY CLARENCE HOLTZMAN,
Waller High School, Chicago, Ill.

A method of training punpils to easily classify insects into their respective orders has been in use at Waller High School, and is so simple that it is practically automatic.

The general plan: The laboratory is equipped with (1) thirty boxes each containing an indiscriminate collection of 20 insects, covering all orders, mounted and numbered under glass, each box labeled with a letter on the end.

(2) thirty check slips of tough manilla board are correspondingly lettered and numbered from 1-20. On these are written the correct orders of the insects in the corresponding cases.

The work is taken up, preferably after several weeks work with type insects. An explanation is first made to the class, viz, each pupil is to have one box and a slip of paper on which he enters the heading JOHN SMITH, Box C, %—, Score—. then the numbers 1-20 are placed consecutively along the left margin. With a key to the orders for a guide, insect number one is scrutinized and entered as being a lepidoptera, diptera or its proper order, numbers 2-20 ditto.

The pupil then goes to the teacher's desk and checks the slip with the correct list for Box C, entering the per cent and score on his slip on the following algebraic basis.

%	Score of points won.	%	Score of points won.
100	35	80	5
95	20	75	0
90	15	70	–5
85	10	65	–10 etc.

A second scrutiny of the case may show that number 12 was really a hymenoptera instead of a diptera. "I won't get caught on that again."

Another box is completed and a 90 or 95% stimulates the pupil to try for a 100 with its attendant bonus of 35 points for a perfect score.

The first box is hard, the second or third easy and the "rest of them are fun," so much, in fact, that if ten boxes are required, summing a total of 200 insects, the members

of the class will work extra periods, lunch hours, and after school to pile up a large score of points, and after doing twenty-five or thirty boxes, will ask for more.

The capable member who has the highest score when time is called, is christened "Chief Bughunter" with appropriate ceremony, while the one who has the lowest score is consoled as being "Bughouse."

The final summary sheet of each pupil lists the letter, percent, and score of each box done and the total score and average percent of all boxes.

The study is almost universally approved by the pupils, who acquire a habit of classifying insects at sight as neurops, hymenops or other 'ops rather than as just "bugs."

Preparation of boxes. Have the planing mill or wood shop prepare a supply (75 ft.) of basswood or poplar strips $\frac{1}{4}$ x $1\frac{1}{2}$ inches, each strip having a $\frac{1}{8}$ inch rabbet on each edge of one side.

These are framed into boxes so that 5 x 7 photo plates will just fit into the rabbetted area. Line the frame with white gummed paper and use black gummed paper for covering and for sealing the glass front and back. Glue ten quarter-inch cubes of cork to the inner surface of one glass, adding a few drops of honey, karo or glycerine to the glue to toughen it.

Pin twenty insects to the corks, assorting these among the various orders, so that no two boxes are duplicates. Bind this glass into the bottom of the box and on the inside of the top glass, number the insects with drawing ink so that the numbers are just over the specimens.

Seal the front or top and letter the end of the box. This makes an equipment which can be used hundreds of times with almost no deterioration and is always ready at a moment's notice.

Photo plates, 5 x 7, may be cheaply bought from the local photographer and readily cleaned by immersing singly in a bath of boiling hot Gold Dust suds until the gelatin loosens.

The ingenious teacher will find the wood strips, if made in various widths, is ideal material for use in mounting frog skeletons, bird skins, leaves, and other fragile or costly supplies.

Credit for the above plan is due Dr. H. E. Walter of Brown University, onetime biology teacher in Chicago schools.

THE MATHEMATICS USED IN SOLVING PROBLEMS IN HIGH SCHOOL CHEMISTRY.

BY J. L. RENDAHL,

Petersburg, N. Dak.

This study of the mathematics used in solving the problems in high school chemistry was undertaken in order to throw additional light on the general question of what mathematics is needed in studying the high school subjects. It may also be of some practical value to the chemistry teacher in providing a basis for diagnostic and remedial work in classes which are having difficulty with the quantitative problems in high school chemistry.

The purpose of this study is to determine what mathematics is used in solving the quantitative problems of high school chemistry.

As a means of securing data the problems were taken from three chemistry text books which had been chosen at random from the list of approved text books for North Dakota high schools. Only the problems at the end of chapters were taken. Problems were not taken from the text material in the chapters since such problems were so few as to be negligible. Supplementary problems found in the appendices were not included in this study since they are not as a rule solved by the entire class.

The textbooks furnishing the problems were: (1) McPherson[1] and Henderson, "Chemistry and Its Uses"; (2) Dull[2], "High School Chemistry"; and (3) Greer[3] and Bennett, "Chemistry." In this report the books will be referred to by number.

[1]McPherson, William and Henderson, William Edwards. Chemistry and Its Uses. Chicago: Ginn and Company, 1925, 456p.

[2]Dull, Charles E. High School Chemistry. New York: Henry Holt and Company, 1925. 577 p.

[3]Greer, Carlotta S. and Bennett, J. Cora. Chemistry. Chicago: Allyn and Bacon, 1926. 766+60 p.

The problems were selected to meet two criteria: (1) they must require computation, and (2) they must have numerical answers. In cases where a single statement involved two or more problems each requiring separate computation and a separate answer, each was handled as a separate problem. A total of 396 problems was found in the three text books.

In so far as possible the problems were solved in the simplest way. In cases where the textbook gave directions or presented examples the methods suggested were followed. Thus similar problems from different texts may not be solved in the same way. The attempt was made to solve the problems in the way that students using that text would solve them.

When the problems had been selected and solved the various operations were tabulated. In some cases the size of the numbers used in the various operations was noted. This was not done throughout the study as in most operations small numbers present no difficulties.

Of the total of 396 problems found, text No. 1 had 173 problems or an average of 40 problems per hundred pages, text No. 2 had 144 problems or an average of 26 problems per hundred pages, and text No. 3 had 79 problems or an average of 10 problems per hundred pages. This indicates that there is considerable difference in the number of mathematical problems found in the various textbooks in high school chemistry.

Multiplication is the most used of the fundamental processes. The use of subtraction in the chemistry problems is practically negligible. Addition of whole numbers or decimals is found 232 times in the 396 problems; subtraction, 24 times; multiplication 604 times; and division 360 times. Fifty per cent of the operations are multiplication, 30 per cent are division, 19 per cent addition, and one per cent subtraction. There are no cases of addition, subtraction, or division of common fractions. Multiplication of common fractions is found 88 times.

In text No. 1 most of the cases of multiplication of common fractions are found in connection with problems based upon chemical equations. In text No. 2 the problems on

the gas laws furnish most of the cases of multiplication of common fractions found in that book.

The denominators of the fractions are of various sizes and degrees of complexity. Only 8 of the denominators are one place numbers. These include the denominators 2, 3, 4, and 8. Six denominators are two place numbers. The numbers 38, 44, 60, 76, and 96 appear in this group. There are 34 denominators of three places. Of these 760 is most common, appearing ten times. Fifty-four of the denominators are decimal numbers. Three have one decimal place, 25 have two decimal places, and 26 have three decimal places.

Of the numerators 49 are decimal numbers, 45 are whole numbers of two or more digits, and 8 are whole numbers of one digit.

All the cases of fractions with numerators and denominators containing decimals are found in text No. 1. Fractions with numerator and denominator over 100 are frequent in text No. 2. In text No. 3 all denominators are under 10.

All of the numbers used in the fundamental operations on whole numbers and decimals in text No. 1 were tabulated according to the number of digits and number of decimal places.

Sixty-one per cent of the numbers used in addition are decimals. The highest number of digits is seven. Eighty nine per cent of the addition problems have two or three addends.

Fifty-six per cent of the numbers used in subtraction are decimals. The largest number used is one of five digits.

Forty-two per cent of the numbers used in multiplication are decimals. The largest number used is one of eight digits. The greatest number of decimal places is five. Ninety-seven per cent of the numbers used in multiplication have five digits or less.

In the division operations 71 per cent of the numbers are decimals. Sixty-one per cent have two or more decimal places. The largest numbers have eight digits. These numbers are of sufficient size and complexity to cause some difficulty in division.

Examples of the three cases in percentage are found in

each of the three books investigated. In 73 problems the base and rate are given, in 46 problems the base and percentage are given, and in 20 problems the rate and percentage are given.

The proportion with one unknown is found 69 times. Text No. 1 avoids the use of proportion entirely in solving chemistry problems. Although the method of proportion is frequently used by chemists it is not necessary to conclude that the process is essential to the student of high school chemistry. The study of proportion is optional in many courses of study in arithmetic and many students are unfamiliar with it.

When the method of proportion is used in solving chemical equations two of the terms are generally numbers representing molecular weights and are decimal numbers.

In the 396 problems solved the square of a number, the cube of a number, and the cube root of a number are each found once. No higher powers or roots are found. The problem involving the cube root is one in finding the dimensions of a cubical box with a volume of 1000 c. c. It does not require a knowledge of the usual procedure in finding cube root.

Fundamental operations on minus numbers are infrequent. Adding of signed numbers is found eight times, all in connection with thermometer readings. In no case are minus numbers found in subtraction. Multiplication by negative numbers occurred twice and division once.

Chemical equations are found 124 times. Balancing the equation involves addition and multiplication of small numbers.

Numbers are substituted in a formula in 14 cases.

Fractional equations of the first degree and with one unknown occurred 33 times and similar equations without fractions, 58 times.

Only a little direct use is made of measurements in solving the 396 problems studied. The following situations were found: (1) finding the dimensions of a cubical box when the volume is given; (2) finding the volume of a rectangular box when the dimensions are given; (3) finding the volume of a cylinder when the length and diameter are given.

Problems of this type are usually included in the work of seventh and eighth grade arithmetic.

Thirty-four different units of measure are used in the chemistry problems from the three texts. Text No. 1 uses 21 different units, text No. 2 uses 17, and text No. 3 makes use of 12 different units. The five most commonly used units are the gram, liter, pound, cubic centimeter, and ton.

Thirty-eight per cent of the units on the list are based on the metric system. The metric units, being so little used in daily life, may be unfamiliar to many pupils in high school chemistry classes.

Text No. 3 uses only two units of measure from the metric system, the gram and liter.

Forty-five instances of reduction of denominate numbers are found in the three books. The most frequent reduction is from ton to pounds, found 14 times. The following reductions occurred more than once in any one book: liter to cubic centimeters, kilograms to grams, inch to centimeters, pound to ounces, ton to pounds, and quart to pints.

The mathematical terms found in the 396 problems from the three texts were listed. They include units of measure, terms denoting mathematical processes and concepts and quantitative relations between numbers, measurable qualities where the quantitative element is important, and other terms having strictly a mathematical meaning. Cardinal and ordinal numbers are, of course, mathematical terms, but they are not listed as they do not add appreciably to the difficulty of the vocabulary in this case. Terms having several meanings are included only when the mathematical meaning is evident.

The 173 problems of text No. 1 have a range of 54 mathematical terms of which 61 per cent are found on Thorndike's[1] word list. The vocabulary of the 144 problems in text No. 2 has a range of 45 mathematical terms of which 71 per cent are found in Thorndike's list of 10,000 most common words. The vocabulary of the 79 problems in text No. 3 has a range of 28 mathematical terms, 61 per cent of which are found in Thorndike's list. A total of 82 different mathematical terms are found in the vocabulary of the 396 problems in the three books.

[1]Thorndike, Edward Lee. The Teachers Word Book. New York: Teacher's College, Columbia University, 1921.

The following terms are most frequently used: gram (119 times), weight (118 times), per cent, %, (83 times), liter (70 times), volume (68 times), and pound (60 times).

The following terms are common to the three books: calculate, equation, gram, liter, per cent, percentage, pound, temperature, volume, weight, ° (degree).

Only thirty of the mathematical terms used in the problems are not found on Thorndike's list, and sixty per cent of these terms are units of measurement.

The following is a list of the mathematical terms found in the problems with their frequency of occurrence:

gram, 119
weight, 118
per cent, %, 83
liter, 70
volume, 68
pound, 60
calculate, 52
degree, °, 51
cubic centimeter, 46
temperature, 34
pressure, 28
centigrade, C., 27
millimeter, 25
ton, 24
standard, 22
kilogram, 21
formula, 17
molecular weight, 15
daily, 14
percentage, 13
ounce, 12
approximate, 11
equation, 11
calorie, 10
gram-molecular weight, 8
cubic foot, 7
constant, 6
gallon, 6
increase, 6
centimeter, 5
Farenheit, 5
amount, 4
capacity, 4
carat, 4
compare, 3
hour, 3
reduce, 3
relative, 3
cent, 2
cubic inch, 2
cupful, 2
density, 2
equal, 2
gram-molecule, 2
inch, 2
number, 2
part, 2
proportion, 2
quantity, 2
quart, 2
ratio, 2
answer, 1
atmosphere, 1
atomic weight, 1
average, 1
calculation, 1
calorific value, 1
compute, 1
cost, 1
cubical, 1
diameter, 1
decimeter, 1
dimensions, 1
diminish, 1
height, 1
kilometer, 1
length, 1
mathematically, 1
measurement, 1
meter, 1
mile, 1
minute, 1
mole, 1
pint, 1
price, 1
relation, 1
result, 1
specific weight, 1
square inch, 1
teaspoonful, 1
total, 1
weekly, 1

The technical vocabulary of chemistry problems is not limited to mathematical terms, as there are also many chemical terms of a technical nature.

On the basis of these findings the following conclusions can be drawn with reference to the mathematics used in solving the problems found in these three chemistry texts:

(1) The fundamental operations on whole numbers and

decimals is slightly complicated by large numbers and numerous decimals.

(2) Multiplication is the only operation used upon common fractions. Fractions with large numerators and denominators further complicated by decimals are found in the problems of some texts.

(3) The three variations of the percentage problem are found in all of the texts examined.

(4) It is possible to avoid the use of proportion in solving chemistry problems.

(5) The more important uses of algebra are in solving simple and fractional equations of the first degree and with one unknown and in substituting in a formula.

(6) The use of geometry is negligible.

(7) Only 34 different units of measure are used in the three books. Thirty eight percent of the units are based on the metric system.

(8) Not over 54 different mathematical terms are found in the vocabulary of the problems from any one book. Sixty-two percent of them are among the 10,000 commonest words.

(9) There is considerable variation in the texts examined as to the number of mathematical problems, the use of large fractions, the use of proportion, fractional equations, and the metric system.

SCIENCE QUESTIONS.

Conducted by Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio.

This number of Science Questions is primarily a "question" number. Please note the questions from our colleagues in India and help reciprocate by sending numerous June examination papers to the Editor.

Chemistry Students from Bishop McConnell High School will find in this number an answer to their "Bismuth problem" from Mr. E. A. Hollister, Pontiac, Mich.

WHAT SHALL WE DO NEXT YEAR?
Suggestions, please. Thanks! The Editor.

ACKNOWLEDGMENTS

544. *The "Monkey Problem"—as proposed by Dave Cervin, Rock Island, Ill.*

Additional solutions have been received from Harry Frye, Tullahoma, Tenn.; Robert N. Wagman, Lincoln Place, Pa.; Glenn F. Hewitt, Chicago, Ill.

Tests in General Science from D. G. Vequist, Saint Joseph, Mo.

"Thought-Provokers" from L. Paul Miller, Scranton, Pa. *Other Tests including Light* from L. Paul Miller.

QUESTIONS FROM INDIA.

558. *Submitted by B. B. Kamat, Esq., Inspector of Science Teaching, Bombay Presidency, Poona, and M. Bedekar, Esq., Supt. Khandesh Education Society's High School, Amalner, Bombay, India.*

Messrs. Kamat and Bedekar ask the Editor to send them copies of similar questions set in the U. S. A., especially for college matriculation. Please send two copies each of your June examinations to the Editor and he will forward them to our Indian friends.

DEPARTMENT OF PUBLIC INSTRUCTION, BOMBAY.

HIGH SCHOOL PRELIMINARY EXAMINATION.

Saturday, 22nd February, 1930 (Time allowed, 2½ hours. Marks, 75).

ELEMENTARY SCIENCE-PHYSICS AND CHEMISTRY. (*Theoretical.*)

(Reprinted for the use of private schools)

N. B. *Return this paper.* All answers *must* be written on *this* paper. At the top of this page write your name in full, name and place of your school and your seat number.

In question (1) you score + 1 mark when correct and — 1 mark when incorrect. Mere guess-work will, therefore, be bad for you.

1. According as a statement is (*a*) true or (*b*) false enter T or F *exactly inside* the square in the proper column and a dash in the other:

e. g. A table is an animal— — F

	No.	T.	F.
1. Hot air is lighter, bulk for bulk, than cold air (1)	1		
Camphor, like wax, melts when heated (2)	2		
Water at 4°C. contracts when cooled (3)	3		
Mechanical energy can be obtained from heat energy (4)	4		
Solids carry sound better than gases (5)	5		
The up-thrust on a body immersed in water depends upon the weight of the body (6)	6		
Hydrogen is a good oxidising agent (7)	7		
The doctor's thermometer is really a maximum thermometer (8)	8		
A ship sinks deeper in sea-water than in river-water (9)	9.		
Air is a bad conductor of heat (10)	10		
The principle of the parallelogram of forces determines the resultant of parallel forces (11)	11		
The T° of the human body is 98°C. normally (12)	12		
A kilometer is longer than a mile (13)	13		
Dissolved impurities can be got rid of by distillation (14)	14		

Soap-solution can produce free lather with temporary hard water (15)	15		
Dilute sulphuric acid acting on zinc gives sulphur dioxide (16)	16		
Filling up a foot-ball with a foot-ball pump is a case of Boyle's law (17)	17		
Copper when burnt decreases in weight (18)	18		
A candle when burnt decreases in weight (19)	19		
The temperature of a mixture of ice and salt is 18 degrees *above* the zero of a Fahrenheit thermometer (20)	20		
When equal weights of lead and water are heated through 5°C. both get the same quantity of heat (21)	21		
A barometer measures the pressure of the atmosphere but cannot measure heights of mountains (22)	22		
When a gun is fired, you hear the sound and see the flash at the same time (23)	23		
A whale, like all aquatic animals, breathes with its gills (24)	24		
Green plants convert light energy of the Sun's rays into chemical energy (25)	25		
Total Marks 25			
2. Fill up the gaps in the following so that the statements remain quite true: Methyl orange turns (26).....with an acid	26		
Lemon juice changes litmus colour from (27).....to	27		
Burning magnesium converts steam to (28)	28		
Concentrated sulphuric acid heated with copper gives (29)	29		
Using a single moveable pulley to lift a load, the force required is (30).....times that with a fixed pulley	30		
The work done in the former is (31).....times that in the latter (31)	31		
Sea water is hard because it contains (32)	32		
The cross bars of a Satar are meant to change (33)	33		
The two important properties of a chemical compound are 34	34		
35	35		
Cleaning an oiled pot with wood-ashes is a case of chemical combination called (36)	36		

Air slowly passed over heated copper filings gives (37)	37		
The principle of the dynamo is to get an electric current by cutting.....with.....(38).....	38		
From the electrolysis of water, we learn that water consists of (39).....	39		
Total Marks 14			

3. Strike off the incorrect statements or words and retain or write the correct ones in the following:

Liquids decrease in (mass, volume) when they are cooled (40).....	40		
Wood feels warmer to the touch than iron in winter because (*a*) wood is hotter than iron, (*b*) iron is a better conductor of heat (41).....	41		
A stone floats on (water, mercury, kerosene oil) (42).....	42		
The atmosphere is (drier, more moist) in summer than in winter (43).....	43		
Of two mercury barometers, the height of the mercury in the one with the narrower tube is (greater than, equal to, less than) that in the other (44).....	44		
When sound travels, what actually travels is (ether-particles, air-particles, condition of particles) from the speaker's mouth to the hearer's ears (45).....	45		
Brass is (an alloy, an element, a compound) of copper and iron (46).....	46		
The purest form of iron is (cast iron, wrought iron, steel) (47).....	47		
The density of water is (10 grams per cc., 1000 grams per litre, 1 lb. per cubic foot) (48).....	48		
A stone suspended with a string is in (stable, unstable, neutral) equilibrium (49).....	49		
Marks 49			

4. (*a*) Add together 5.732 deka-metres, 5 kilometres, 14-09 decimetres and 136 mm. and record answers (1) and (2).
   Answer (1).....metres.
   (2).....cms.
   (*b*) 1st level of water in a burette—69-5 cc.
   2nd level of water in a burette—60-0 cc.
   Number of pellets of lead shots thrown in..... =50
   Therefore the volume of one pellet = (3).....cc. (ans.)
   (*c*) A flask holds 27 ozs. of water. What weight will it hold of an oil whose specific gravity is 0-95?
   (4).....qms.
   (*d*) To deprive air of its carbonic acid gas, pass it through a solution of
   (5).....
   (*e*) To remove moisture from Hydrogen, pass it through
   (6).....

Total marks 6

5. Draw rapid sketches in pencil in the space provided to show:
(*a*) That the pressure of water sideways increases with depth.
(*b*) The position of the source of light in the head lights of a motor car and how the reflector is helpful.
(*c*) A floating zinc-copper cell carrying a solenoid.
(*d*) How white light is decomposed by a prism, and recomposed by another.
(*e*) The construction of a horse-shoe electromagnet, particularly to show how the current passes in it.
(*f*) Three pendulums (*drawn to scale*) whose periods of vibration are 2 in., 4 in. and 6 in. (seconds) respectively.

Marks 12

6. Explain clearly—(on the reverse of this page).
(*a*) Why the rails are not on the same level on the curved portion of a railway.
(*b*) How the spring in an electric call-bell helps to ring the bell.
(*c*) Describe an experiment to show the composition of water by weight, adding a clear diagram of a key.

Marks 9

Draw the sketches for Question V here below.

QUESTIONS FROM CANADA.

559. *Submitted by Robt. J. Davidson, Esq., Scott Collegiate Institute, Regina, Saskatchewan.*

MECHANICS. FORM IV. GRADE XII.

1. (a) Explain the terms acceleration, momentum, power, moment of force. (b) State the law of universal gravitation. What is the difference between the terms weight and mass? Which of these is invariable? Explain why the other may vary slightly at different places on the earth.

2. (a) What is meant by a vector quantity? Give an example stating why you consider it a vector.

(b) A steamer can travel 12 mi. an hour in still water. If the current in a river flows 5 mi. per hour, how long will it take the steamer to travel 1 mile up stream? If kept headed directly across the stream, how far will it travel in 10 minutes? Show by a diagram its direction and motion in the latter case.

3. Define mechanical advantage of a machine, work, energy (Kinetic).
(b) What is the mechanical advantage of a windlass whose crank is 2½ ft. long and the diameter of the axle is 6 inches?
(c) How long a plank would be required to load a barrel into a truck 3 ft. high if the mechanical advantage of this device is the same as that in (b)?

4. A bullet weighing 50 g. is fired vertically upward with a velocity of 500 metres per sec.; returning it penetrates the ground to a depth of 200 cm. (a) How long was it in the air? (b) How high did it rise? (c) What was its kinetic energy on striking the ground? (d) With how great force did the earth resist the penetration of the bullet? In what unit is your result expressed?

5. A bomb weighing 100 lbs. is dropped from an airplane which is traveling 120 mi. per hour at a height of 8,000 ft. (disregard the resistance of the air). (a) How soon will it strike the ground? (b) Where will it strike the ground? e. i., how far from the point which was directly below the airplane at the instant the bomb was released? (c) How much kinetic energy and how much potential energy did the bomb have just before it was dropped? How much and what kind of energy does it have when it strikes the ground?

6. A boy standing on a bridge threw a stone weighing two pounds to a height of 16 ft. The stone in falling missed the bridge and fell to the water, 128 ft. below the bridge. Find: (a) How long the stone was in the air. (b) The initial and final velocities of the stone. (c) The final kinetic energy of the stone.

7. (a) Show that the kinetic energy of a moving body is $\frac{1}{2}MV^2$ where M is the mass in grams and V is the velocity of the body in cm. per sec. (b) With what velocity must a lead bullet strike a target in order that it may be melted by the heat generated by the impact? The heat of fusion of lead is 5.4 calories per gram. Assume that all the heat generated remains in the bullet. (The mechanical equivalent of heat is 42,000,000 ergs). (c) A team of horses draws a load of 2 tons at three miles an hour along a level road. If the frictional resistance amounts to 1-20 of the weight of the load, at what rate is the team working?

8. (a) A certain force gives a mass 1,000 units of momentum in 5 sec. What velocity will the same force give in 10 sec. to a mass of 5 g.? (b) A balloon rises with a uniform velocity of 2 metres per sec. At the end of one minute a stone is thrown downward from the balloon with a velocity of 2 metres per sec. In what time will the stone strike the ground, and what will be its velocity just before striking?

9. It is found that it required a force of 120 lbs. to draw with uniform velocity a 400 lb. mass up a rough plane 3 ft. high and 12 ft. long. Find: (a) The force of friction. (b) The force required to let the mass move down the plane without acceleration. (c) The work done in moving this mass up the plane. How much of this work is stored up as potential energy?

10. A boy sitting on a coaster wagon (total weight 120 lbs.) starts from rest at the top of an inclined plane 9 ft. high and 26 ft. long. Find the (a) acceleration and the time to reach the bottom, (b) work required in climbing back up for another run, (c) force another boy would have to exert, pulling on a level surface, to give the boy on his wagon an acceleration of 2 ft. per sec.

11. A 3000 lb. automobile starting from rest attains a speed of 30 m. p. h. in 15 sec. (a) Find its acceleration in feet per second. (b) How far did it travel in this time? (c) How much energy does it now possess? (d) What horse power was used to produce this energy in the 15 sec.?

12. (a) A man walking 4 mi. per hour walks east 1 hr., northeast 2 hrs., northwest 1½ hrs., and south ½ hr. Represent graphically his path, using equally spaced dots on a line to represent units. (b) Draw a line representing the resultant of all his movements and estimate how long it would have taken him to have gone directly to the final point.
(c) When he was going northeast, what was the easterly component of his velocity. (Solve by either a graphical or an algebraic method.)

13. (a) State the parallelogram law of forces and describe the essential steps of an experimental method of proving this law.
(b) A force of 20 g. acts for 10 sec. on a 490 g. mass. Find the acceleration produced and the distance moved in that time.

14. (a) Show how the resultant of two concurrent forces may be determined graphically. Explain by diagram and description an experimental method of establishing this law or principle.
(b) If it requires a force of 40 lbs. parallel to the surface of an inclined plane to pull up a 65 lb. weight when the plane rises 5 ft. in 13 ft., what is the coefficient of friction between the weight and the plane?

15. (a) Describe an experimental method for verifying the law of the parallelogram of forces. Explain using diagrams exactly how this experiment shows that the law is true.
(b) Make a clear sketch of some system of pulleys having a mechanical advantage of three.

16. An engine exerts a pull of 200 lbs. on a 20 ton train for a distance of ½ a mile. The train's velocity was then found to be 15 m. p. h.
(a) How much kinetic energy does the train now possess?
(b) How much work did the engine do in this time?
(c) Apply the law of conservation of energy to this problem and account for the discrepancy between the answers to (a) and (b).

17. A force of 100 dynes acts upon a mass of 1kg. for one minute. Find the velocity acquired and the space passed over in this time.

18. A shot from a gun weighing three tons has an initial velocity of

1200 ft. per sec. and weighs 10 lbs. What is the initial velocity of the recoil?

19. A boy who exerts a push of 50 lbs. weight wishes to roll a barrel weighing 200 lbs. into a wagon 2½ ft high. Assuming that he pushes in a line through the centre of the barrel parallel to the plank, how long a plank will he need and how much work will he do?

20. A man weighing 150 lbs. sits on a platform suspended from a moveable pulley and raises himself by a rope passing over a fixed pulley. Supposing the cords are parallel what force does he exert?

21. A wheel whose radius is 25 cm. is fastened to one end of a screw whose pitch is one mm. What force can the screw exert when a force of 1 kg. weight is applied tangentially to the wheel, friction being supposed negligible?

22. (a) How much water must a 10 h. p. water turbine utilize per minute if the height of the falls is 33 ft., assuming an efficiency of 80%?

(b) What force must an engine exert to give a 1,000 kg. car a velocity of 18 km. per hour in 20 seconds after starting it from rest? How far will it go in attaining this velocity?

23. (a) Make a diagram of a pulley system that would enable a force of 50 lbs. to just lift a weight of 150 lbs. if friction were eliminated? (b) If it were found that a force of 55 lbs. were required on account of friction, what is the efficiency of the system?

(c) Through what distance would a boy have to exert this force of 55 lbs. in order to raise the weight 10 ft.? What horse power would he have to exert to accomplish this in 10 sec.?

24. (a) A referee dropped a puck weighing ½ lb. a distance of 4 ft. What was its velocity and its momentum at the instant it struck the ice.

(b) If two hockey players simultaneously struck the puck, the one with a blow that would have sent it forward with a velocity of 40 ft. per sec., and the other with a blow that would have sent it to the right with a velocity of 30 ft. per sec., find by means of a diagram the direction and the magnitude of the resultant velocity.

(c) If it travelled for 8 sec., and a distance of 200 ft. before coming to rest, what was its acceleration?

QUESTIONS FROM THE U. S. A.

560. *Submitted by Wm. F. Rice, Head of Science Department, Jamaica Plain High School, Boston, Mass.*

BIOLOGY—MID-YEAR EXAMINATION, 1930, SECOND YEAR PUPILS

Number your answer paper with the number of this paper.

Group I.

Answer every question in Group I.

1. (a) Draw and label fully the cross section of a leaf.
   (b) Give functions of each structure labelled.
2. Make a comparison of a monocot and a dicot plant.
3. Write out the nitrogen cycle.
4. (a) What happens when bacteria enters the body?
   (b) Distinguish between natural and acquired immunity.

Group II.

Answer any two questions in Group II.

5. (a) Make a fully labelled drawing of a typical flower.
   (b) Give the function of each structure labelled.
6. Given an apple, how would you find out what nutrients are present?
7. Classify: bacteria, Boston fern, apple tree, palm tree, bread mold, spirogyra, moss, gladiolus, club moss, paper white narcissus, white pine, bean plant.

PHYSICS—MID-YEAR EXAMINATION, FEB. 12, 1930, THIRD YEAR PUPILS

Write the number of this paper at the head of your answer paper. Do

not write on this question paper. Do your "scratch work" freely on your answer paper, but try to keep it orderly. Number each answer to correspond to the question. Plan to take time to check over your answers. The following material is supplied for reference. *Specific Gravity of Mercury 13.6, normal pressure 15 lbs. per sq. in.,* $\frac{Wv^2}{2g}e = kl(t' - t)$. Questions 1, 2, 3 and 4 are required.

1. What is the density of water (a) in metric units, (b) in English units? (c) A block 6x8x10 cm. weighs 1200 grams. What is its density? (d) Where should the center of gravity of a body be to give it great stability? (e) In what position would the block mentioned in (c) be most stable?

2. (a) A body weighing 200 grams in air and having a volume of 250cc. is placed in water. Does it float or sink? If it floats, what volume is under water? If it sinks, what does it weigh in water? (b) Find the specific gravity of a body which weighs 650 grams in air and 475 grams in water. (c) What is its volume?

3. (a) A weight of 4 tons is lifted 2 inches by a machine worked by a man who pushes with a force of 80 lbs. through a distance of 20 feet. Find the efficiency. (b) The physicist classifies machines into six classes. Name four of these classes of machines.

4. (a) A bridge has steel suspension wires 5000 ft. long at a temperature of 10 F. How long do they become when the temperature is 90 F. (Coefficient for steel on F scale is .000006.) (b) What is abnormal about the way water changes in volume with change of temperature.

Answer any two of the questions 5, 6, 7, 8.

5. (a) Describe and explain an experiment to show that the atmosphere exerts pressure. (b) What instrument is used for measuring atmospheric pressure? How is it made? (Use sketches.) What does it read normally?

6. A force of 120 grams is applied at the 10 cm. mark on a meter stick, and another of 80 grams in the same direction at the 75 cm. mark. A force of 60 grams is applied in the opposite direction at the 90 cm. mark. Make a careful diagram. (a) Find the direction. (b) The magnitude. (c) The point of application of the force which will produce equilibrium.

7. (a) A projectile weighing 8 lbs. has a velocity of 1200 ft. per sec. How much and what kind of energy has it? (b) What did Galileo prove by using the Tower of Pisa? (c) By means of an inclined plane? (d) Why is a pendulum useful in a clock?

8. (a) A tank contains 3 cu. ft. of oxygen gas at a pressure of 1600 lbs. per sq. in. and a temperature of −9 C (minus 9 C). What volume would this gas occupy at normal atmospheric pressure and a temperature of 27 C? (b) Name two uses of compressed air. (c) Name a use for a vacuum.

CHEMISTRY—MID-YEAR EXAMINATION, 1930, FOURTH YEAR PUPILS

Write the number of this paper at the head of your answer paper. Do not write on this question paper. Do your "scratch work" freely on your answer paper but try to keep it orderly.

Number and letter each answer to correspond to the number and letter of the question.

Plan to take time to check over your answers.

Atomic Weights: N14; Na23; Al27; S32; Cl35.5.

Questions 1, 2, 3, and 4 are required.

1. Answer these questions for any one of the following:
   Oxygen, Hydrogen, Carbon Dioxide.
   (a) How is it prepared and collected?
   (b) Make a labelled sketch of the apparatus.
   (c) Write the equation for the above reaction.
   (d) How does it occur in nature?
   (e) What are its properties, chemical and physical?
   (f) How would you test or identify it?
   (g) What are its uses?

2. (a) What are the constituents of the atmosphere.
Give the approximate proportion of each.
(b) Describe how you would experimentally determine the proportion of two of them.
(c) Which of the other constitutents [not covered by (b)] could you detect readily? Describe how for each.
3. (a) State the Law of Multiple Proportions. Illustrate its meaning carefully.
(b) Give exact directions for preparing a normal solution of sodium hydroxide.
4. (a) What is the weight of a liter of ammonia gas NH_3?
(b) Hydrochloric acid reacts with aluminum to form $AlCl_2$ as one of the products. Write the equation for this reaction.
(c) What weight of acid would be required to produce 89 grams of aluminum chloride?

Answer any two of the questions 5, 6, 7, 8.

5. (a) Describe two methods of purifying water.
(b) What does each method accomplish?
(c) What is the limitation of each method?
6. Name the gases (omit mixtures) you have studied which are: (a) poisonous, (b) inflamable, (c) colored, (d) acids, (e) odorous, (f) very soluble in water.
Write the formula of an actual compound (g) where mercury has a valence of one, (h) where mercury has a valence of two, (i) where sulphur has a valence of four, (j) of aluminum and oxygen. Sec. 4 (b).
7. (a) Consider two liters of hydrogen sulphide to be completely burned. Write the equation for the reaction and give the volumes of all the gases concerned. (b) Describe the test to show that common salt is a chloride. Write the equation for the reaction.
8. (a) What are the uses of sulphur?
(b) Name and give formula of as many compounds of it as you can.
(c) Give details of uses of two of these compounds.

REVIEW OUTLINE FROM CLEVELAND.

561. *Submitted by N. D. McLaughlin, Science Master, University School, Cleveland, Ohio.*

Physics Outline

Density, moments of force, energy, mechanical advantage, work power, force. Horse power, power, coefficient of friction, centripetal force, centrifugal force, efficiency, Pascal's principle, Archimedes' principle, specific gravity, Hook's Law, Boyle's Law, Charles' Law, weight of a liter of air, weight of a cubic foot of air. Fall in Barometer for every 900 ft. All ways of finding specific gravity. Principle of parallelogram of forces, acceleration, velocity, positive and negative acceleration, formulas. Newton's 3 Laws of motion, Dyne, erg, Kinetic energy. To what is g equal? In what units can work, force, and energy be expressed? Conservation of energy, momentum, center of gravity, specific heat, latent heat, distillation, evaporation, relative humidity, B. T. U. and Calorie. Law of universal gravitation. Mechanical equivalent of heat, Joule's experiment, conduction, convection, and radiation. Study of incline plane including friction.

B. T. U.—778 ft. lbs.
1 Calorie—427 gram meters.
1 Calorie—41,800,000 ergs.
Heat of fusion of ice—80 calories.
Heat of vaporization of steam—540 Calories.

Make a list of formulas. Difference between density and specific gravity. Difference between weight and mass. For what two reasons would the apparent weight of a body change if it were taken from the earth's pole to the equator? The Dewar flask and the thermos bottle. Transformation of energy as the pendulum or shooting a bullet up in the air.

CHEMISTRY STUDENTS' PROBLEM.

551. *Proposed by Students of the Bishop McDonnell Memorial High School, Brooklyn, N. Y.*

The atomic weight of bismuth is 208.6. At 1640°C. the average molecular weight of bismuth is 293. What per cent of the molecules of Bi_2 have been dissociated into Bi?

We are very much interested in SCHOOL SCIENCE AND MATHEMATICS and we hope to receive the solution to the foregoing problem through this valuable journal.

Very respectfully yours,
Chemistry Students, E77C72,
Per LILLIAN SCOTT.

Solution by E. A. Hollister, Pontiac High School and Junior College, Pontiac, Michigan.

Let me submit the following solution of the question regarding Bi, No. 551:

Select 100 molecules of Bi_2. (Hand-picked)! 41720 = wt. of these in terms of hydrogen atoms. Let x = No. dissociated at 1640°C. $(100-x)$ will remain Bi_2. The x molecules dissociated will produce $2x$ Bi. The total number will now be $100-x+2x=100+x$.

$$\text{Av. wt.} = \frac{\text{total wt.}}{\text{No. of mol.}}$$

$$293 = \frac{41720}{100+x}$$

Giving $x = 42.4 - = 42.4\%$.

BOOK REVIEWS.

Laboratory Exercises in Zoology, by William M. Barrows, Professor of Zoology, The Ohio State University. Waterproof fabrikoid. viii plus 103 pp. Illustrated. 48 cents. World Book Company, Yonkers-on-Hudson, New York.

Part I of this new laboratory manual of high school zoology consists of thirty exercises. Part II provides a series of twenty-four student projects. The main emphasis is on the study of living forms that can be provided by the students themselves. The course calls for almost no dissection of animals for the study of internal morphology. The emphasis is placed on animal physiology, external morphology and relation to environment where it belongs. The directions for each exercise are given under the headings, Object, Materials, and Procedure. The manual is well adapted for use with the author's textbook, Science of Animal Life, however it could be used with any other good text. Jerome Isenbarger.

Blaidsdell Instructional Tests in Biology for Junior and Senior High Schools, by J. G. Blaidsdell, Chairman Biology Department, Charles E. Gorton High School, Yonkers, New York. World Book Company, Yonkers-on-Hudson, New York. 32 cents. Key 12 cents.

The set consists of a series of twenty-five standardized tests, each covering a unit of work. There are 8 tests on animal biology, 6 on human biology, 7 on plant biology, and 4 on special and general subjects. The tests may be used in any desired order. The principal value of the tests lies in the fact that they set up definite goals to be reached by the pupils as they progress in the course and there is a definite check on the success or failure of each student. Norms are provided as a standard of comparison and for use in setting up definite goals to be reached by the students. Devices of this type offer a great saving of time for the teacher in preparing tests and in marking papers and in fact accomplish much more than the old-type subjective tests. Jerome Isenbarger.

Elementary Science by Grades, Vol. iv. by Ellis C. Persing, Chairman of the Department of Science, School of Education, Western Reserve University and Edward E. Wildman, Director of Science, Philadelphia Public Schools. Published by D. Appleton and Company

This volume is Book IV of a series of six science readers for the elementary school grades being developed under the general editorship of Frank W. Ballou, Superintendent of Schools, Washington, D. C.

The book is made up of 33 chapters, each dealing with a small unit of interest to the child, such as:—The Ant Hill, Wasps That Like Company, Wasps That Live Alone, Our Forest Trees, Our Winter Birds, The Bear, The Milky Way, and Kites. The central theme of the reader is community life.

Each chapter provides motivating questions at the beginning and "Some Things To Think About" and "Some Things To Do" at the end.

The style is such that it should gain and hold the interest of fourth grade children. The vocabulary has been based upon the first, second, and third groups of Gates "A Reading Vocabulary for the Primary Grades" and upon Thorndike's "The Teacher's Word Book."

Simple, interesting illustrations add to the attractiveness of the book. An index suited to child use completes the volume.

A feature which adds much to the usefulness of the book is Suggestions To Teachers giving brief instructions for using the reader, chapter by chapter.

In the opinion of the reviewer this book is a real contribution to the development of worthwhile science for the elementary school.

Harry A. Carpenter.

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Advanced Biology, by Frank M. Wheat, Chairman of the Department of Biology,, George Washington High School, New York, and Instructor of Biology, New York University, and Elizabeth T. Fitzpatrick, Chairman of Health Education, George Washington High School, New York. viii plus 567 pp. American Book Company, 1929.

This book provides material for a second course in biology to be given in the senior high school. It could even form the basis for an excellent course in the first year of college with students without previous training in biology. Emphasis is placed on the historical side of the science. While the organization does not show a division into units, the treatment is about as follows: Early History of Biology, The Cell as the Unit of Life, Morphology and Physiology of Tissues, The Human Organism, Reproduction, Heredity and Improvement of Living Things, Bacteria, Causes and Control of Infectious Diseases. The work is illustrated by numerous excellent original diagrams, photographs, and drawings. Problems are given for use in connection with the laboratory work. At the end of each chapter there are questions for review and lists of books, etc., for supplementary reading. This should prove good text in its field.

Jerome Isenbarger.

Economic Zoology, by Albert M. Reese, Professor of Zoology, West Virginia University. Third Edition. xxi plus 323 pp. 194 illustrations. P. Blakiston's Son and Company, Inc., 1012 Walnut St., Philadelphia. 1930. $2.50.

This is, as the title indicates, a practical zoology, emphasizing the relation of animals to man's welfare. While the book is intended to be used in connection with the work of a brief college course, it is suitable for supplementary reading and to furnish material for reports with high school classes. It gives facts about animals which are not generally known and which aid in holding the natural interest which students have in animals. While some attention is paid to classification and gross morphology, yet the emphasis is placed on the purely economic aspects of the study of animals. The work could be used as a text in a third semester course following a year of zoology or general biology in the high school. It gives the type of zoological information which every one should have. Ten pages of classified references are given in the back of the book.

Jerome Isenbarger.

Educational Biology, by William Lewis Eikenberry, Professor and Head of the Science Department, Trenton, New Jersey, Teachers' College, and R. A. Waldron, Professor and Head of the Science Department, State Teachers' College, Slippery Rock, Pennsylvania. viii plus 549 pp. Ginn and Company. 1930. $2.48.

This course is intended to furnish the biological foundation needed by teachers, however there is no reason why it it not a good foundation course for one who should decide to go on and take his major work in some line of biology. That the organization is a logical one for a foundation course is indicated by the titles of the main divisions of the book, which are as follows: How Plants and Animals Live, Types of Organisms, Adjustment to Environment, Mechanism of Response, and Development of Organisms. The emphasis is on physiology rather than on morphology. The book should prove a useful text in normal school and certain junior college classes in general biology. Teachers of related subjects will find the book useful in furnishing supplementary materials. Questions for thought and discussion are given at the end of each chapter together with a list of references. There is a ten-page glossary which adds to the value of the text.

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Laboratory Construction & Equipment, a report of the National Research Council Committee on the Construction and Equipment of Chemical Laboratories. pp. 13 plus 340-23x16x2 cm., many illustrations of laboratory desks, layouts and equipment. Cloth. Feb. 1930. $1 for the book and an included list of laboratory supply houses. The Chemical Foundation, Inc., 654 Madison Ave., New York City.

An invaluable collection of monographs by experts on each of the phases of chemical laboratory, planning and construction. The chapter headings will indicate the character of the work. Chap. I, The Planning of a Chemical Laboratory by J. N. Swan, Dept. of Chem., Univ. of Miss., and G. L. Coyle, Director, Dept. of Chem., Georgetown Univ. Chap. II, Arrangement of Interiors, Types of Buildings, by J. N. Swan. Chap. III, Location and Exterior Construction, by C. R. Hoover, Chairman, Dept. of Chem., Wesleyan University. Chap. IV, General Ventilation and Heating by C. R. Hoover. Chap. V, Hood Ventilation, by C. R. Hoover. Chap. VI, Lighting, by C. R. Hoover. Chap. VII, Laboratory Tables, by J. N. Swan. Chap. VIII, Plumbing, by C. R. Hoover. Chap. IX, Electrical Equipment, by C. R. Hoover. Chap. X, Service and Storage Rooms, by J. N. Swan. Chap. XI, Lecture Rooms, Class Rooms, Library and Museum, by J. N. Swan. Chap. XII, Offices and Private Laboratories, by J. N. Swan. Chap. XIII, Laboratories for General Chemistry, by J. N. Swan for Colleges, L. W. Mattern, McKinley H. School, Washington, D. C. for High Schools, and G. L. Coyle for small high schools. Chap. XIV, Laboratories for Analytical Chemistry, Qualitatives and Quantitative Analysis, by J. N. Swan, A Laboratory for Gas Analysis, by M. L. Nichols, Asst. Prof. of Anal. Chem., Cornell Univ. Chap. XV, Laboratories for Organic Chemistry, by G. H. Woollett, Prof. of Physiological Chem., Univ. of Miss. Chap. XVI, Laboratories for Physical and Electro-Chem., by V. A. Coulter, Prof. of Physical Chem., Univ. of Miss. Chap. XVII, Special Laboratories, 1, For Chemical Microscopy, by E. M. Chamot, Prof. of Chem. Microscopy, Cornell Univ. 2, A Laboratory for Chemical Spectroscopy, by J. Papish, Prof. of Chem. Spectroscopy, Cornell Univ., 3, Other Special Rooms, by J. N. Swan. Chap. XVIII, The Design of Laboratories for Instruction in Industrial Chemistry—1—The Unit Process Method, by F. H. Rhodes, Prof. of Ind. Chem., Cornell Univ. 2—The Unit Plant Method, by Allen Rogers, Supervisor of the Course in Industrial Chem. Engineering, Pratt Institute, Brooklyn, N. Y. Chap. XIX, Industrial Chemical Laboratories, by A. V. H. Mory, Asst. Director of Research, Bakelite Corp. Bloomfield, N. J. Chap XX, Laboratories for Biochemical Teaching, by C. P. Sherwin, Prof. of Physiological Chemistry, Fordham Univ., Chap. XXI, Sanitary and Biological Research Laboratories, by A. B. Wadsworth, Director, Division of Laboratories and Research, N .Y. State Dept. of Health, Albany, N. Y. The whole report shows competent and careful work on the part of the committee and the book should be procured and studied by every teacher who is to have anything to do with planning new quarters for a chemistry department and by every architect who hopes to do any planning of laboratory buildings.

F. B. W.

Animal Micrology, Revised Edition, by Michael F. Guyer, Professor of Zoology in the University of Wisconsin. xi plus 289 pp., 72 figures. The University of Chicago Press, Chicago. $3.00.

While this book in intended as a guide in technique for the use of college students in beginning classes in histology and bacteriology, primarily, it is a complete handbook for any person doing work in preparing animal materials for microscopical demonstration. It is similar in its scope and treatment, using animal tissues, with the

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excellent companion book, Chamberlain's Methods in Plant Histology, using plant materials. The directions for procedure with reasons are so definitely given that a good student makes successful progress with its aid without the help of a teacher. Besides the chapters of the original edition which have been rewritten, there is an additional chapter on Cytological Methods by the author and another on Drawing by Dr. Elizabeth Smith of the Zoology Department of the University of Wisconsin. Appendix D will be found most useful, not only by teachers in college, but also by teachers of high school zoology as well, as it gives methods of preparing cultures of microscopic animals, and also simple methods of demonstration of these and other materials used in zoology classes.

Jerome Isenbarger.

The Science of Everyday Life (New Edition) by Edgar F. Van Buskirk, Head of Science Department, Stephens College; Edith Lillian Smith, recently instructor, Boston Teachers' College, and Walter L. Nourse, Vice Principal and formerly instructor in General Science, John Burroughs Junior High School, Los Angeles. 1930: Pages xvii+620. Houghlin Mifflin Co.

This revision of the textbook by Van Buskirk and Smith brings the material up to date. The introduction contains many helpful hints to teachers. Many new diagrams are added. The problems and subject material are more closely correlated. Many teacher helps are added throughout the book. The new discoveries in the airplane, the radio, television and the "talkies" are explained.

The changes and additions made in this revision add greatly to the usefulness of this highly successful text book.

I. C. D.

Plane Trigonometry, by Edwin S. Crowley, and Henry B. Evans, University of Pennsylvania. Cloth. Pages v+177. 13.2x20.6 cm., 1930. F. S. Crofts and Co., New York. Price $1.65.

This book is a revision of a previous edition by the same authors. It develops trigonometry in what might be termed the traditional manner. Out of nine chapters, six are given to the development of the trigonometric functions, solution of right triangles, trigonometric properties of angles, trigonometric formulas, oblique triangles, and areas of triangles. The remaining three chapters continue with miscellaneous problems, De Moivre's Theorem, trigonometric series, and hyperbolic functions. The authors state in the preface that this material has been presented with an effort to encourage thinking on the part of the student. They attempt to attain this goal by numerous exercises and problems.

The presentation of the factual material is clear, concise, and lucid, and in scope a minimal rather than an extensive course of trigonometry. In the assimilative material the problems are of the mathematical rather than the "practical" or "appreciative" type. No tables, save two pages of hyperbolic functions are included. The book also lacks an index. To teachers looking for a brief, clear-cut presentation of the essentials of trigonometry, this book will prove interesting and worthy of their attention.

J. M. O'Rourke.

The Teaching of Mathematics in Secondary Schools, vol. 1. Technique., by Ernst R. Breslich, Associate Professor of the Teaching of Mathematics, The School of Education, The University of Chicago. Cloth. Pages 239. 15x22 cm. 1930. The University of Chicago Press.

The text summarizes in a splendid manner the advice that an experienced teacher might give a student who has just graduated from college and accepted her first teaching position. There is advice

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about what to do during the class period, what methods of teaching have been tried in the past and their good and bad points, advice on teaching the pupils how to study, on how to use tests, and how to arouse an interest in mathematics. Each chapter concludes with a good bibliography suggesting further reading. The superintendent who hires a June graduate should insist that the teacher present a well-thumbed copy of the text.

The book is the first of what promises to be a series of books on the teaching of mathematics. A later volume will deal, according to the preface, with the teaching of specific topics.

Joseph A. Nyberg.

Seventh Year, Eighth Year, and Ninth Year Mathematics, by Ernst R. Breslich, Associate Professor of the Teaching of Mathematics, The College of Education, and Head of the Department of Mathematics, The University High School, The University of Chicago. pp. xi+284, ix+296, ix+319, 13.5x19.5 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York.

These three volumes are a revision of Professor Breslich's Junior Mathematics published in 1925. In the first volume especial attention has been given to intuitional and Constructional geometry. Seven chapters, out of nine, deal with geometric material. One chapter deals with various applications of percentage and another, with such problems as those of the home shop, farm, and business.

In the second volume four chapters, out of ten, dealing with geometric material. There are three that deal primarily with the everyday life of the pupil and the community. The remaining three chapters stress formulas, equations, and directed numbers.

The third volume is concerned with algebraic material. Since the first two volumes have developed most of the fundamental algebraic and geometric concepts, the pupil is well prepared for the algebra of the ninth year.

Some general remarks relative to the three volumes should be added

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The student who has assimilated the material of this series of books is well prepared for either a vocation or for further work in mathematics.

J. M. Kinney.

Educational Biology, by John C. Johnson, State Teachers' College, West Chester, Pennsylvania. xx plus 360 pp. 123 illustrations. The Macmillan Company. 1930.

This work is offered as a textbook for teachers' colleges and university schools and colleges of education. It is intended to form the basis for a lecture or discussion course through one semester or quarter. The emphasis is on heredity, evolution and eugenics with special reference to their bearing on the problems of the teacher. There is a movement in some quarters toward an elementary college

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course in general biology consisting of lectures and discussions without laboratory work. This text represents that type of course. While the writer of this review is of the opinion that there can be no real substitute for a basic course including laboratory work as biological training to aid in the preparation of teachers, yet if such a course is desired, this book offers an excellent guide and basic text.

Jerome Isenbarger.

A Study of Problem Material in High School Algebra, by Jesse Jerome Powell, Instructor of Mathematics, College of the City of New York. Pages 100. 1929 Teachers College, Columbia University, New York.

This book reports a study made by the author to determine what problem material is most valuable in helping the child discover his relation to his environment, and in preparing him to be an efficient citizen. With modern aims, objectives, and teaching methods clearly in mind, Mr. Powell has aimed to compile a list of five hundred of the best problems available for an elementary algebra course.

The selection of problems was based upon problems submitted by two hundred-fifty well-trained, experienced teachers of high school algebra, and upon preferences shown for these problems by a large number of high school pupils.

After the data was tabulated and analyzed, a study was made of the relationships existing between the factors, interest, genuineness, importance and difficulty, and a report of this study is found in the Appendix.

In the summary of the study the author brings out some interesting conclusions:

1. A large representative group of teachers of mathematics believes that the problems the average citizen are most concerned with deal with some kind of material advancement, and so they rank such problems high in importance.
2. There is a high correlation between the degree of importance and the amount of interest teachers think pupils will show.
3. The pupils' interest in a problem does not depend on its importance as defined by the teacher. Activity is one of the chief elements of interest to the pupil.
4. Knowing the relationship which seems to exist between genuineness, importance, interest, and difficulty, the teacher can more wisely select problems, and plan a more effective presentation.

In the appendix is found a discussion of the salient points in methods of teaching problems, and the list of problems compiled, along with a list of important formulas.

The study has been conducted in a scientific manner, and should be of interest to all curriculum makers. It is to be hoped that it may lead to further and more extended study, and to a more thoughtful selection of problem material to be included in algebra text books.

Minnie Goodhue.

The Supervision of Elementary Subjects, edited by William H. Burton, Associate Professor of Education in The University of Chicago. Cloth. Pages xix+701. 12.5x19 cm. 1929. D. Appleton and Company, 35 West 32nd Street, New York. Price $2.40.

The following quotation from the Preface indicates clearly the purpose of the book. "This volume is an effort to supply the generalist (superintendent, assistant superintendent, general supervisor, building principal) with a brief, compact summary of material of value to him in supervising the various elementary school subjects. It has distinctly not been prepared with the special-subject supervisor in mind. For the latter specialists, separate volumes for each subject would be desirable."

In the first chapter the Editor lays down what he considers to be

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the fundamental principles and aims of supervision. In this connection the principle is stressed that supervision is not inspection of the teacher and her work but a sympathetic, democratic and cooperative effort on the part of the teacher and supervisor to improve instruction.

Each of the other thirteen chapters in the volume have been written by specialists in the various fields. These chapters deal with the supervision of the following subjects: Arithmetic, Spelling, Reading, Handwriting, Language, Geography, History, Civics, Nature Study, Music, Art, Industrial Art, Health Education and Physical Education. Although thirteen different specialists cooperated in the project, the volume has unity of aim and purpose, since a rather consistent theory of supervision has been adhered to throughout the entire volume.

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1. To provide him with a consistent theory of the supervisory function, namely, that the purpose of supervision is not to inspect the teacher's work, but to assist and inspire her to more effective teaching. 2. It gives him a comprehensive view of the specific aims of the various subjects in the elementary school curriculum. 3. It provides him with a fundamental theory in the supervision of the various subjects in the elementary school. 4. It provides him with specific methods for measuring the results of teaching of the different subjects. 5. It gives him many valuable suggestions and devices for the enrichment of the elementary school subjects.

M. H. Schlichting.

Introduction to the Theory of Numbers, by Leonard Eugene Dickson, Professor of Mathematics, University of Chicago. pp viii+183. 14x20 cm. 1929. The University of Chicago Press, Chicago, Illinois. Price $3.00.

This is an elementary treatise on the Theory of Numbers. Excepting Chapter X, no mathematical training beyond College Algebra is required. Those topics which require extensive analytic treatment are omitted.

This book will interest teachers of elementary mathematics who desire an introductory knowledge to this old and fascinating subject.

J. M. Kinney.

The Calculus, by Hans H. Dalaker, Ph.D., Professor of Mathematics and Mechanics, University of Minnesota, and Henry E. Hartig, Ph.D. Electrical Engineering Department, University of Minnesota. pp. viii+254. 15.5x23.5 cm. 1930. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York. Price $2.25.

In this book the theory is stated concisely, but clearly. Numerous graded exercises follow the development of formulas for the purpose of supplying material for the necessary formal drill. We find many concrete problems which provide an opportunity for applying the theory. There are many excellent figures.

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BOOKS FOR THE POPULAR SCIENCE SHELF.

Below are brief descriptions of excellent science books of the popular type—the kind the girls and the boys and their parents all want to read at once.

Heroes of the Air by Chelsea Fraser, Author of "Heroes of the Wilds," "Heroes of the Sea," etc. Twenty-nine maps and forty-two photographs. Revised Edition. Pages xvi+562. Cloth. 13.5x19.5 cm. 1930. Thomas Y. Crowell Company, New York. Price $2.00.

This is the ninth edition of a book already well known. It tells in an interesting and accurate way the marvelous stories of the daring heroes who have made aerial travel a success. Starting with the soap bubble story of Tiberius Cavallo the author gives a rapid survey of the progress made by the Montgolfiers, the Roberts, John Wise, Coxwell and Glaisher, Langley, the Wrights, Count Zeppelin, Lindberg and a host of others that have written the history to the present. All this is done in twenty-four pages. The remainder of the book is made up of thrilling stories with such titles as these: "The First Flight Across the Atlantic," "Across the Continent on the Shenandoah," "Flying Over the North Pole," "Three Flights From America to Europe in One Year," etc. The final chapter consists of brief accounts of eleven famous flights of the last three years, the eleventh telling of Byrd's dash to the South Pole. Forty-two pictures and twenty-eight charts help to make the reader more intimately acquainted with the fliers and their voyages.

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Heroes of the Farthest North and Farthest South by J. Kennedy MacLean and Chelsea Fraser. Cloth. Pages xiv+472. 13.5x19.5 cm. 1930. Thomas Y. Crowell Company, New York. Price $2.00.

The appearance of this book, just as Byrd is returning from his great explorations in Antarctica, is very timely. When we hear or read the story of that great series of adventures we shall want to compare it with the brilliant and hazardous journeys previously made to the lands of snow, ice and silence. This book both supplies that need and provides a complete history of the polar explorations to the present time. Twenty-four chapters tell vividly the arctic

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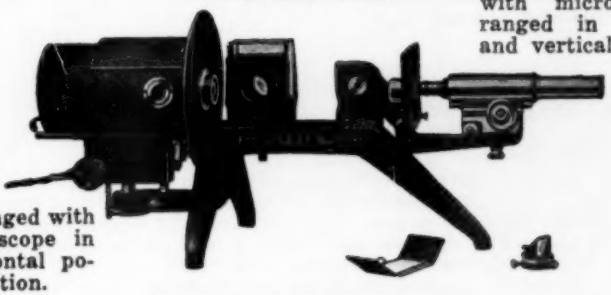

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The New World of Physical Discovery by Floyd L. Darrow, Author of The Story of Chemistry, etc. Illustrated. Cloth. Pages 7+371. 15x23 cm. 1930. The Bobbs-Merrill Company, Indianapolis, Indiana. Price $3.50.

This is the book science teachers and pupils have been seeking—a book that tells in language understandable to those who have not specialized in physical science the story of the revolutionary discoveries in physics of the past half century, and explains the theories based on those discoveries. To those who have read *The Story of Chemistry* Floyd L. Darrow needs no introduction. *The New World of Physical Discovery* is his latest contribution to popular science education and is a worthy companion to his earlier great book.

In five very interesting chapters the author tells the story of classical physics emphasizing only those parts which are necessary to an understanding of the great experiments of recent date. The remainder of the book, more than any other single volume that has come to the writer's attention, answers the puzzling questions so often put to us by our pupils and our non-science trained friends. What is an atom like? What is a photon? Einstein, Laue patterns, a finite universe, sunlight by the ton, Schrödinger atoms, cosmic rays—all these and a hundred other mysteries are cleared up for the layman more satisfactorily than we had thought possible except to the elect.

The final chapter "Physical Discovery and Civilization" should be read by everyone. Few people realize or even stop to consider how much their happiness, the common place conveniences, and even the bare necessities of life depend upon scientific discovery. The scientist's toy of today is the giant of power, the fleet messenger, or the angel of mercy tomorrow. The investigator works for the joy of discovery and the rest of us profit by and enjoy his inventions.

G. W. W.

Insects Ways by Clarence M. Weed, Principal of the State Normal School, Lowell, Mass. Illustrated. Cloth. Pages vii+343. 12.5x19 cm. 1930. D. Appleton and Company, 35 West 32nd Street, New York. Price $1.36.

This book was written for use as a supplementary reader for pupils of the upper grades and junior high school. It tells in story form but with scientific accuracy many interesting things of the insect world. While reading for entertainment the child learns the life history of the butterflies with their complete life changes, the grasshoppers with incomplete life changes, how insects make use of camouflage, their mortal combats, safety first devices, how they deceive their enemies and lure their prey. One chapter tells how insects use tools; another, how they spend the winter; and another describes the biggest insects. While learning about and enjoying the stories of insect life, many interesting ideas of plant life and natural phenomena are incidentally acquired.

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BOOKS RECEIVED.

Calculus by Egbert J. Miles, Associate Professor of Mathematics in Yale University and James S. Mikesh, Master in Mathematics in the Lawrenceville School. First Edition. Cloth. Pages xiii+638. 14.5x23 cm. 1930. McGraw-Hill Book Company, 370 Seventh Avenue, New York. Price $3.75.

Specimen Objective Examinations by G. M. Ruch, Professor of Education, University of California, Berkeley, California, and G. A. Rice, Associate Professor of Education, University of California, Berkeley, California. Cloth. Pages vi+324. 14x21.5 cm. 1930. Scott, Foresman and Company, 623 South Wabash Avenue, Chicago, Illinois. Price $1.80.

Green Magic, The Story of the World of Plants by Julie Closson Kenly. Cloth. Pages xv+194. 13x18.5 cm. 1930. D. Appleton and Company, 35 West 32nd Street, New York. Price 92 cents.

Chemistry for Today by William McPherson and William Edwards Henderson, both Professors of Chemistry in the Ohio State University, and George Winegar Fowler, Head of the Science Department, Central High School, and Supervisor of Science, City Schools, Syracuse, New York. Pages xi+588. 13x19.5 cm. 1930. Ginn and Company, 15 Ashburton Place, Boston. Price $1.80.

A General Science Workbook by Charles H. Lake, First Assistant Superintendent of Schools, Cleveland, Ohio, Louis E. Welton, Assistant Principal and Head of Science Department, John Hay High School, Cleveland, Ohio, and James C. Adell, Teacher of Science, John Hay High School, Cleveland, Ohio. Paper. Pages vi+346. 20x27 cm. 1930. Silver, Burdett and Company, New York. Price $1.40.

Heroes of the Farthest North and Farthest South by J. Kennedy MacLean and Chelsea Fraser. Cloth. Pages xiv+472. 13.5x19.5 cm. 1930. Thomas Y. Crowell Company, New York. Price $2.00.

The Book of Knowledge edited by Ellis C. Persing, Department of Science, School of Education, Western Reserve University. Cloth. 591 pages. 16x24 cm. 1929. The Grolier Society, 2 West 45th Street, New York.

Objective Tests for High School Physics by C. J. Peters, formerly Supervisor of Science, University High School, Columbia, Missouri, and R. K. Watkins, Associate Professor of Education, University of Missouri, Columbia, Missouri. Paper. 36 pages. 15x22.5 cm. Seventeen tests on fundamentals and seventeen parallel tests on applications. MECHANICS: Weights and Measures, Liquids, Gases, Molecular Physics, Force and Motion, Work Power and Energy, Simple Machines; HEAT: Thermometry and Expansion, Heat and Work, Transference, Change of State; SOUND—two sets; LIGHT; MAGNETISM and STATIC ELECTRICITY; CURRENT ELECRICITY: Effects of Current Electricity, Electromagnetic induction.

The Teaching of Mathematics in Secondary Schools by Ernst R. Breslich, Associate Professor of the Teaching of Mathematics, The School of Education, University of Chicago. Cloth. Pages viii+239. 15x22 cm. 1930. The University of Chicago Press, Chicago, Illinois. Price $2.00.

The Science of Everyday Life by Edgar F. Van Buskirk, Head of the Department of Science, Stephens College, Columbia, Missouri, and Edith Lillian Smith, recently Instructor, Boston Teachers College and assisted by Walter L. Nourse, Vice-Principal, formerly Instructor in General Science, John Burroughs Junior High School, Los Angeles. Cloth. Pages xvii+620. 12.5x19 cm. 1930. Houghton Mifflin Company, 2 Park Street, Boston. Price $1.60.

Alternating Currents for Technical Students by Calvin C. Bishop, Head of the Department of Drafting and Design Technical High School, Buffalo, New York. Cloth. Pages viii+317. 13.5x19.5 cm. 1930. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York.

BOOKS RECEIVED.

The Science of Biology by George G. Scott, Professor of Biology in the College of the City of New York. Revised Edition. Cloth. xx+633. 14x21.5 cm. 1930. Thomas Y. Crowell Company, New York. Price $3.75.

Standard Service Flash Cards by J. W. Studebaker, Superintendent of Schools, Des Moines, Iowa, F. B. Knight, College of Education, University of Iowa and W. C. Findley, Elementary School Principal and Supervisor of Mathematics, Public Schools, Des Moines, Iowa. Cards for class use 4"x7" Set 1 Addition 100 cards, Set 2 Subtraction 100 cards, Set 3 Multiplication 100 cards, Set 4 Division 90 cards. Price $1.80 per set. Individual Flash Cards 2"x3½" Set 5

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Test Method Helps, Number One. Manual for Transmuting Standardized Test Scores into Terms of School Marks by A. S. Otis and J. S. Orleans. Paper. 17 pages. 13.5x20.5 cm. 1930. World Book Company, Yonkers-on-Hudson, New York. Price 10 cents.

Stuff, The Story of Materials in the Service of Man by Pauline G. Beery, Assistant Professor of Chemistry in Pennsylvania State College. Cloth. Pages xiii+504. 14x21.5 cm. 1930. D. Appleton and Company, New York. Price $5.00.

SHOOTING STARS.

Meteor Crater, a mysterious hollow in the ground, near Coon Butte, in Arizona, contains a giant meteor which is believed to have fallen there in the more or less remote past. It is being investigated, to recover, if possible, some of the valuable metals it contains—iron, nickel, and traces of platinum, to mention but three of the substances the meteor may contain.

It is not surprising that meteors—fireballs, or shooting stars—have always seemed fearful to primitive folk, who no doubt saw in them portentous messengers from heaven. Perhaps they were missiles hurled by an angry god? Or fiery dragons hurtling across the sky? Today, of course, meteors are known to be fragments of cosmic matter. The very large and brighter ones are called bolides, or fireballs, the smaller ones shooting stars.

Meteors range in size from ordinary shooting stars to fireballs such as that which may have fallen in Arizona. Fireballs, however, are rather rare. Shooting stars are common, and may often be seen, on nights when there are no clouds or moon, in any part of the world. Their flash is usually less than a second in duration. Many are so faint that they can be seen only with powerful telescopes.

Shooting stars, large or small, are small stones or chunks of mineral matter from outer space. When these travelers through space encounter the atmosphere of the earth, the friction engendered raises them to white heat or causes them to burst into flame as shooting stars or fireballs. Comparatively few meteors survive this fiery ordeal; most are completely burned up. A few which reach the earth's surface are called meteorites.

Primarily, a meteor is anything to be observed in the air; for, according to Webster's New International Dictionary, the word comes from a Greek word meaning "things in the air."

One stone from cosmic space may have three different names, depending on its position relative to the earth. Outside the earth's atmosphere all such small bodies are called meteoroids. Those that encounter the atmosphere of the earth, and are heated to visible heat, are called meteors. If a meteor is not completely burned up, and reaches the earth, what remains of it is called a meteorite.

Certain times of the year are marked by showers of meteors. Such showers happen when the earth meets exceptionally large groups of these cosmic bodies traveling through space, and as thousands of them strike the atmosphere they give an appearance of a shower of shooting stars. The Perseid shower occurs in August; the Orionid shower in October; the Geminid shower in December; and so on. Some of these showers may be caused by the earth plunging through the orbit of a comet which passed long ago, the meteoroids being remnants of the comet's tail.

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SCIENCE AND THE TARIFF.

Tariff seems a very routine affair. Can there be romance in it? A list of the articles frequently under consideration by official examiners of U. S. tariffs is certainly crammed with hints of bygone days and of strange foreign lands.

Borax is one of these suggestive articles;—a mineral found in its native form only in California, Nevada, and far-away Tibet. The name is probably ultimately Persian in origin, but found its way into European languages from the Arabic word, "buraq," as early as the ninth century A. D.

Carillon duty concerns few, but it has been the center of much tariff agitation. A carillon is a set of bells played by keys or other machinery. To import a $250,000 carillon for the Park Avenue Baptist Church, John D. Rockefeller would have to pay a duty of $100,000. Friends of music and craftsmanship favor a repeal of the forty per cent duty on carillons. Carillon is a French word, meaning "a chime of bells."

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